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FORESTRY PAMPHLETS

HAWAII

Vol. IV.

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TERRITORY OF HAWAII

BOARD OF AGRICULTURE AND FORESTRY

DIVISION OF HYDROGRAPHY

G. K. LARRISON, Superintendent

REPORT

OF THE

Division of Hydrography

FOR THE

Biennial Period Ending December 31, 1916

Reprint from the Report of the Board of Commissioners
of Agriculture and Forestry

HONOLULU, T. H.
STAR-BULLETIN PRESS
1917

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Forestry

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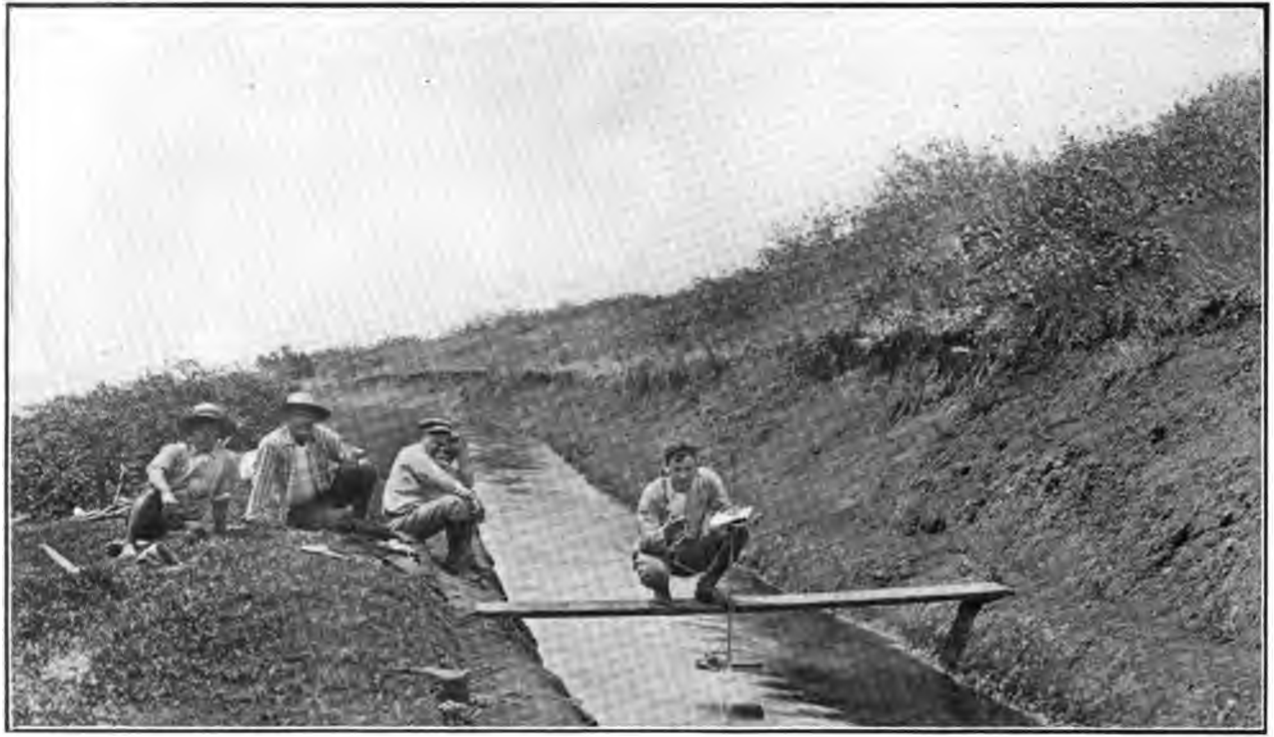


HYDROGRAPHER READY TO MAKE CURRENT METER MEASUREMENT, HONOKAHAU DITCH, MAUI.

Division of Hydrography

Report of the Superintendent of Hydrography

Honolulu, Hawaii, December 31, 1916.

The Board of Commissioners
of Agriculture and Forestry,
Honolulu, Hawaii.

Gentlemen:

The following report of operations of the Division of Hydrography for the biennial period ending December 31, 1916, is submitted:

The hydrometric work of the Territory of Hawaii during this biennial period has been carried on in cooperation with the U. S. Geological Survey.

SCOPE OF WORK.

In addition to the general investigation of the surface waters of Hawaii, which has been continued along the same lines as in the past, a large portion of the time and funds available for this division has been used to investigate the water resources owned by the Territory of Hawaii.

Previous to the calendar year 1914 the primary function of the Division of Hydrography was to make an inventory of the surface water resources of the Territory, including privately-owned waters. During 1914 and since that year, this division has been called upon to gather data and furnish recommendations relative to water utilization, including water duty, ditch losses, flood storage problems, and water valuation. The scope of the work has also broadened to include activities relative to city water supply, military water problems, and legal snarls. In fact the originally most important work of gathering data relative to stream, ditch, and spring discharge has been crowded into a position of secondary consideration by the so-called more practical phases of the work above mentioned. However, it should be remembered that the work of ascertaining the surface water resources of the Territory has not deteriorated nor merely held its own. This work has gone ahead satisfactorily. At the same time the valuation, legal, and utilization work has developed to an extent that requires more than half of the time and funds available.

The demand for valuation work has been brought about largely by the fact that several Territorial water licenses, under which private corporations now pay fixed annual rentals for the use of the waters involved, will terminate in the near future. The value and necessity of accurate data relative to the amounts of water furnished is recognized by all concerned. The advisability of fixing some method under which the amount of water furnished and the value of the crop irrigated or power obtained, will control the price to be paid, is also recognized by all men who are big enough to place the good of the community above their own private interests.

GENERAL INVESTIGATION OF SURFACE WATER RESOURCES.

The general investigation of the surface water resources progressed favorably. Geographically, the work has been extended very little and has been limited to the islands of Kauai, Oahu, and Maui, except for a few rainfall measurement stations which have been established on Molokai and Hawaii. From the viewpoint of intensity and efficiency, however, the work has gone ahead tremendously. All existing stations have been repaired and improved to an extent which results in a large increase in the value of the data obtained.

On Kauai continuous-record measurement stations equipped with the most modern water-stage recording instruments were established on the three main branches of the Waimea River (Territorial waters), at an elevation of about nine hundred feet above sea level. The same type of stations were also established on the Kapaa Stream, and the Kapaa and upper Anahola ditches.

Concrete "controls" were built on five co-operative* stations on Oahu which increase the value of the data obtained at least one hundred per cent. Four new cooperative continuous-record measurement stations were established in the upper Kaluanui, Punaluu, and Waiahole valleys.

About 25 temporary cooperative stream and ditch measurement stations in the Kailua, Kaneohe, and Heeia valleys on Oahu were discontinued on June 30, 1916, as having served their purpose.

On Maui all existing stream measurement stations were repaired and put in first-class condition and two new continuous-record measurement stations were established on the Ukumehame and Lahainaluna streams. The first is owned by the Territory and the second partially so, the water being divided with Pioneer plantation on an hourly basis.

---

*Cost of installation paid by private corporations or persons. Operation cost paid by this Division.

WATER UTILIZATION WORK.

A large amount of information has been gathered relative to water duty, ditch seepage and other losses, evaporation, high level rainfall, flood storage, the relation between rainfall and run-off in the vicinity of Honolulu, Schofield Barracks water supply, and similar problems.

A special investigation relative to the existing and future water supply of Schofield Barracks was made and a report with recommendations made to the military authorities.

Work was continued on the flood storage investigation being made in the vicinity of Kahuku and Laie on Oahu.

An investigation was made to determine the possibility of flood storage at the headwaters of the Waimea, North Wailua, Kapaa and Anahola rivers on Kauai. Possible flood storage sites were located on the Kokee and Kawaikoi branches of the Waimea River, and in several large gulches tributary to the North Wailua, Kapaa, and Anahola rivers. Recommendations have been made that funds for surveys of these sites be appropriated by the 1917 legislature.

An investigation made by this division of ditch seepage or leakage losses on one of Oahu's plantation flood water ditches resulted in that plantation expending about $40,000.00 to line the ditch.

WATER VALUATION WORK.

An investigation relative to the value of Territorial waters involved under existing land leases and water licenses to private corporations was made and a report furnished the Governor of Hawaii. This report dealt with the various water-bearing lands owned by the Territory in detail.

At the request of the Governor of Hawaii a proposed method for fixing the price to be paid the Territory for waters used under future water licenses was devised and submitted for his approval. Under this method the price to be paid per million gallons would be fixed annually and be based on the mean price of sugar in cents per pound at New York during the previous calendar year and the tonnage per acre of the land irrigated when the water is used for sugar cane irrigation or fluming.

HONOLULU'S WATER SUPPLY.

The investigation of surface water resources which may be used to augment the water supply of Honolulu was continued. All surface streams of sufficient size to justify consideration as possible sources of supply for the city are now under investigation.

The artesian well supply has been carefully studied and a comprehensive report with recommendations relative thereto has been made to the Governor of Hawaii by the Territorial Water Commission.

LEGAL WORK.

During the past two years this division has worked in close cooperation with the Attorney General's Department of the Territory of Hawaii, and much time and effort have been given to the legal aspect of the waters owned by the Territory. Much assistance was rendered in the Waimea, Hawaii, water ownership controversy between the Territory and the Parker Ranch, and in the Hilo Boarding School ditch case.

Preparations are now being made for a large amount of this class of work in connection with several similar water ownership disputes between the Territory and private corporations which will probably be taken up in 1917 and 1918.

RAINFALL MEASUREMENT STATIONS.

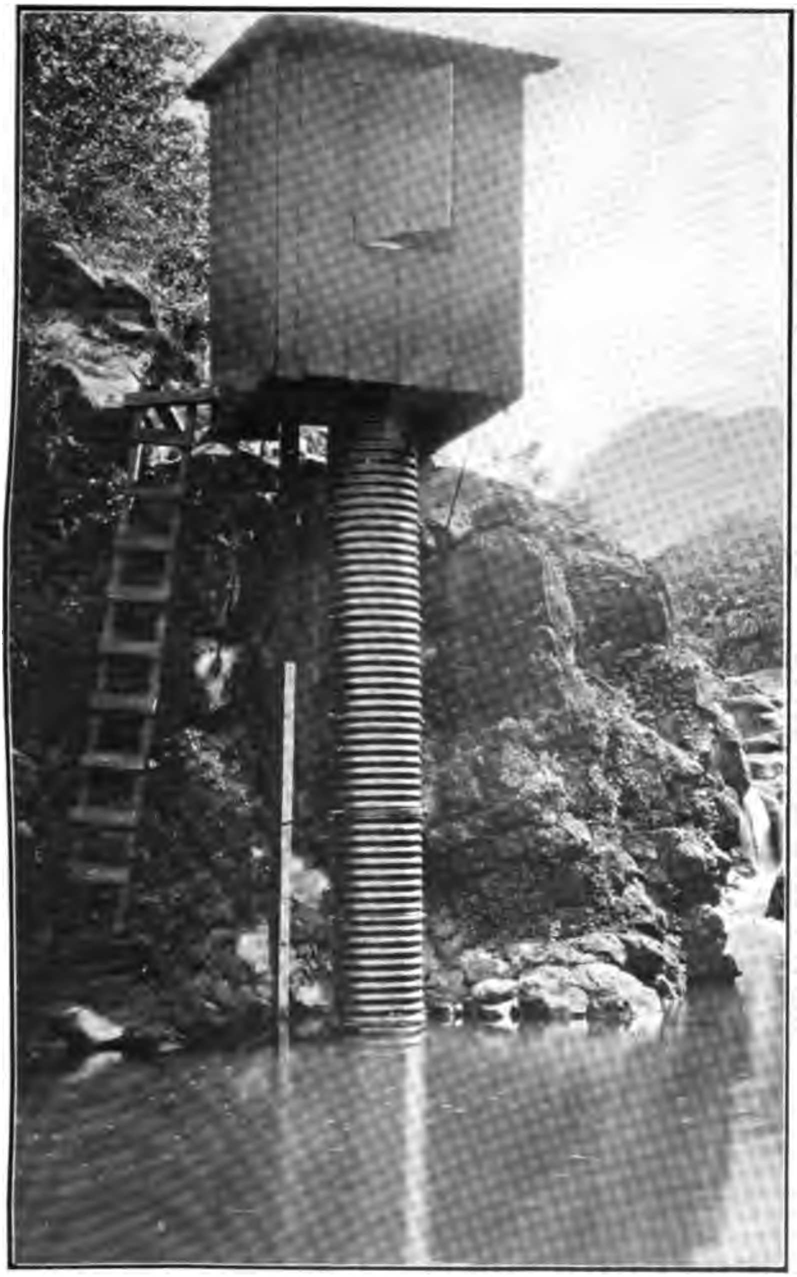
The U. S. Weather Bureau publishes only rainfall data which may be obtained from daily readings. In order that the amount of rainfall on high ridges and at practically inaccessible localities might be obtained, a type of rain gage was designed which could be read at monthly or bi-monthly intervals. To measure the evaporation which must be lost from these gages during these long periods, an evaporation measurement gage was also designed.

Monthly and bi-monthly rain gages with evaporation gages have been maintained at various points of the Territory, as shown in the following tables.

PUBLICATION AND AVAILABILITY OF INFORMATION.

The daily discharge, with other detailed data pertaining to the streams, ditches, etc., under investigation have been published by the U. S. Geological Survey in the form of annual printed reports which are furnished free to all applicants on request to this office or to the Washington, D. C., office. A shortage of funds and a pressure of work at the Printing Office at Washington, has caused the printing of these reports to be delayed from twelve to twenty-four months after the close of the report year. In order that the information collected may

Plate 10.



CLOCK REGISTER SHELTER, KALIHI STREAM, OAHU.

reach the public without delay, this division will mail or furnish blue print copies of data pertaining to any stream, ditch, or locality for which information is desired. All original data are also kept on file at Rooms 17 to 22, Kapiolani Building, King and Alakea Streets, and are available for the public at all times.

Attention is invited to the following tabulations showing the status and progress of the work.

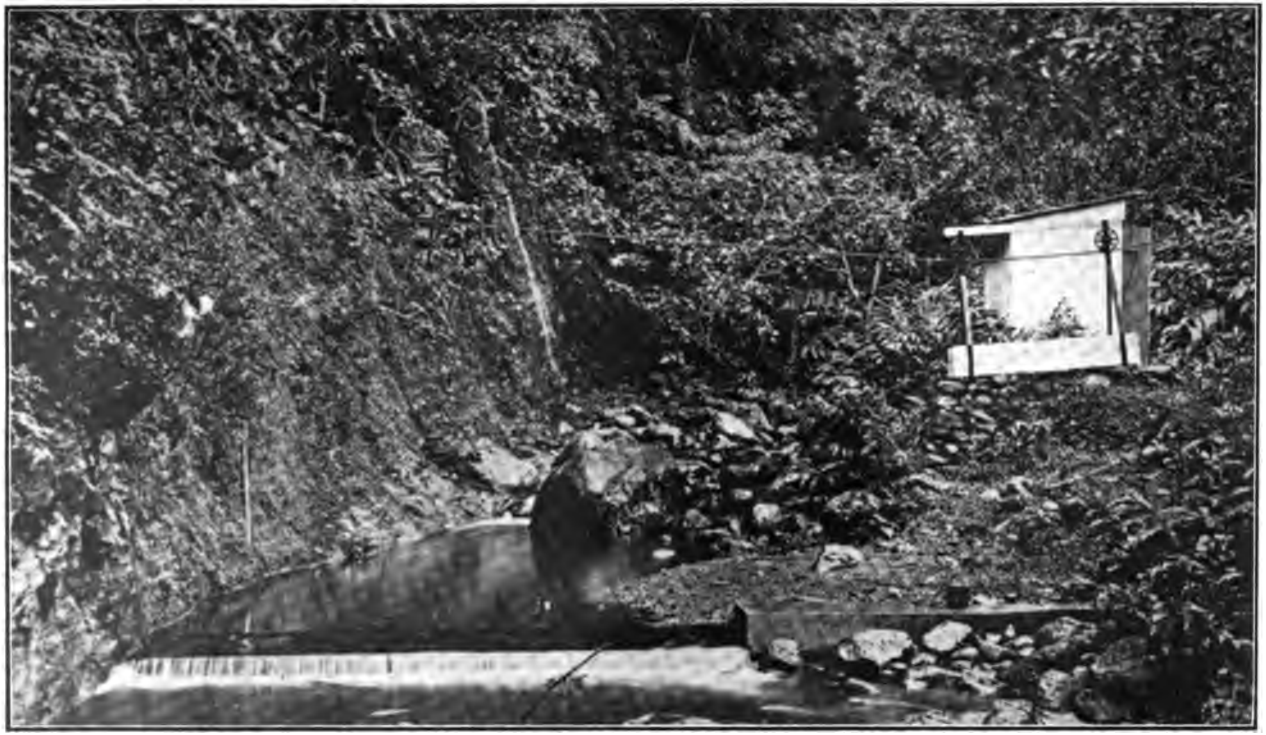
Very respectfully,

G. K. LARRISON,
Supt. of Hydrography.

STREAM MEASUREMENT STATIONS.

	ISLAND.				Total
	Kauai	Oahu	Maui	Hawaii	
Number of Regular Gaging Stations:					
Maintained on January 1, 1915	25	32	35	....	92
Established during biennial period	4	4	8	....	16
Discontinued during biennial period	9	15	15	....	39
Maintained on December 31, 1916	20	21	28	....	69
Total number operated during biennial period	29	36	43	....	108
Measurements:					
Made at regular stations during biennial period	343	276	215	....	834
Made at miscellaneous points during biennial period	34	26	4	25	89

Plate 11.



KOLOA STREAM GAGING STATION, OAHU, SHOWING CLOCK REGISTER SHELTER, CABLE AND CAR, STAFF GAGE, AND CONCRETE CONTROL.

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LIST OF STREAM GAGING STATIONS MAINTAINED BY THE DIVISION OF HYDROGRAPHY DURING BIENNIAL PERIOD JANUARY 1, 1915-DECEMBER 31, 1916.

ISLAND OF KAUAI.

Stations Established.

1, Koaie River near Waimea; 2, Olokele River near Makaweli; 3, Waiahulu Stream near Waimea; 4, Waialae River at mouth near Waimea.

Stations Discontinued.

1, Hanapepe River at Hanapepe Falls near Eleele; 2, Hanapepe River at Falls, East Branch, near Eleele; 3, Hanapepe River at Koula near Eleele; 4, Huleia River near Lihue; 5, Kauaikinana Stream near Waimea; 6, Kilauea River near Kilauea; 7, Mohihi River near Waimea; 8, Waialae River near Waimea; 9, Waiakoali Stream near Waimea.

Stations Maintained on December 31, 1916.

1, Anahola River near Kealia; 2, Hanalei River near Hanalei; 3, Hanalei River at 750 feet elevation near Hanalei; 4, Kalihiwai River near Hanalei; 5, Kapaa River near Kapaa; 6, Kawaikoi Stream near Waimea; 7, Koaie River near Waimea; 8, Lumahai River near Hanalei; 9, Makaweli River near Waimea; 10, Olokele River near Makaweli; 11, Waiahulu Stream near Waimea; 12, Waialae Stream at mouth near Waimea; 13, Wailua River, North Fork, near Lihue; 14, Wailua River, South Fork, near Lihue; 15, Wailua River, East Branch of North Fork, near Lihue; 16, Waimea River near Waimea; 17, Wainiha River near Hanalei; 18, Wainiha River, East Channel, near Wainiha; 19, Wainiha River, West Channel, near Wainiha; 20, Waioli Stream near Hanalei.

ISLAND OF OAHU.

Stations Established.

1, Kaluanui Stream near Hauula; 2, Punaluu Stream near Hauula; 3, Waiahole Stream below power house near Waiahole; 4, Waihoi Stream near Punaluu.

Stations Discontinued.

1, Hooleinaiwa Stream near Kaneohe; 2, Iolekaa Stream near Heeia; 3, Kailua Stream near Kailua; 4, Kahanaiki Stream near Kailua; 5, Kaimi Stream near Kailua; 6, Kamakalepo Stream near Kailua; 7, Kaneohe Stream near Kaneohe; 8, Kawa Stream near Kaneohe; 9, Kuou Stream near Kaneohe; 10, Luluku Stream near Kaneohe; 11, Makawao Stream near Kailua; 12, Piho Stream near Kaneohe; 13, Waiahole Stream near Waiahole; 14, Waiahole Stream below power house near Waiahole; 15, Waiahole Stream below power house near Waiahole.

Stations Maintained on December 31, 1916.

1, Haiku Stream near Heeia; 2, Kahana Stream near Kahana;

3, Kahana Stream, East Branch, near Kahana; 4, Kalihi Stream near Honolulu; 5, Kahawainui Stream, East Branch, near Laie; 6, Kaluanui Stream near Hauula; 7, Koloa Stream near Laie; 8, Kaukonahua Stream, Left Branch of North Fork, near Wahiawa; 9, Kaukonahua Stream, Right Branch of North Fork, near Wahiawa; 10, Kaukonahua Stream, South Fork, near Wahiawa; 11, Kaukonahua Stream, South Fork, below U. S. Army Reservoir, near Wahiawa; 12, Malaekahana Stream, East Branch, near Kahuku; 13, Malaekahana Stream, Middle Branch, near Kahuku; 14, Manoa Stream, East Branch, near Honolulu; 15, Manoa Stream, West Branch, near Honolulu; 16, Manoa Stream at College of Hawaii, near Honolulu; 17, Nuuanu Stream below Reservoir No. 2 near Honolulu; 18, Punaluu Stream at 250 feet elevation near Punaluu; 19, Punaluu Stream at 539 feet elevation near Punaluu; 20, Wailele Stream near Laie; 21, Waihoi Stream near Punaluu.

ISLAND OF MAUI.

Stations Established.

1, Kauaula Stream near Lahaina; 2, Lahainaluna Stream above pipe line intake, near Lahaina; 3, Launiupoko Stream near Lahaina; 4, Left Branch Iao Stream near Wailuku; 5, Ukumehame Stream near Olowalu; 6, Waikapu Stream near Waikapu; 7, Waiehu Stream, North, near Wailuku; 8, Waiehu Stream, South, near Wailuku.

Stations Discontinued.

1, Halehaku Stream near Huelo; 2, Iao Stream near Wailuku; 3, Iao Stream, Left Branch, near Wailuku; 4, Kahakuloa Stream near Kahakuloa; 5, Kauaula Stream near Lahaina; 6, Lahainaluna Stream near Lahaina; 7, Launiupoko Stream near Lahaina; 8, Oanui Stream near Huelo; 9, Olowalu Stream near Olowalu; 10, Opana Stream near Huelo; 11, Oopuola Stream near Huelo; 12, Ukumehame Stream near Olowalu; 13, Waiehu Stream, North, near Wailuku; 14, Waiehu Stream, South, near Wailuku; 15, Waikapu Stream near Waikapu.

Stations Maintained on December 31, 1916.

1, Alo Stream near Huelo; 2, Haipuaena Stream near Huelo; 3, Hanawi Stream near Nahiku; 4, Honokawai Stream near Lahaina; 5, Honokohau Stream near Honokohau; 6, Honolua Stream near Honokohau; 7, Honomanu Stream near Keanae; 8, Honopou Stream near Huelo; 9, Hoolawaliilii Stream near Huelo; 10, Hoolawanui Stream near Huelo; 11, Kahoma Stream near Lahaina; 12, Kailua Stream near Huelo; 13, Kauaula Stream near Lahaina; 14, Kopiliula Stream, West, near Keanae; 15, Lahainaluna Stream above pipe line intake, near Lahaina; 16, Launiupoko Stream near Lahaina; 17, Nailiilihaele Stream near Huelo; 18, Puohakamoa Stream near Huelo; 19, Ukumehame Stream near Olowalu; 20, Waiehu Stream, North, near Wailuku; 21, Waiehu Stream, South, near Wailuku; 22, Waihee Stream near Waihee; 23, Waikamoi Stream near Huelo; 24, Waikapu Stream near Waikapu; 25, Wailuaiki Stream, East, near Keanae; 26, Wailuaiki Stream, West, near Keanae; 27, Wailuanui Stream, East, near Keanae; 28, Wailuanui Stream, West, near Keanae.

DITCH MEASUREMENT STATIONS.

	ISLAND.				Total
	Kauai	Oahu	Maui	Hawaii	
Number of Regular Gaging Stations:					
Maintained on January 1, 1915	12	15	7	....	34
Established during biennial period	7	3	3	....	13
Discontinued during biennial period	3	15	3	....	21
Maintained on December 31, 1916	16	3	7	....	26
Total number operated during biennial period	19	18	10	....	47
Measurements:					
Made at regular stations during biennial period	146	70	45	....	261
Made at miscellaneous points during biennial period	14	83	16	14	127

LIST OF DITCH GAGING STATIONS MAINTAINED BY THE DIVISION OF HYDROGRAPHY DURING BIENNIAL PERIOD JANUARY 1, 1915—DECEMBER 31, 1916.

ISLAND OF KAUAI.

Stations Established.

1, Anahola ditch near Kealia; 2, Kaholalele ditch near Lihue; 3, Kapahi ditch near Kapaa; 4, Kekaha ditch (makai) near Kekaha; 5, Kekaha ditch (mauka) near Kekaha; 6, Kuna ditch near Hanalei; 7, Waimea ditch near Waimea.

Stations Discontinued.

1, Hanapepe ditch at Hanapepe Falls near Eleele; 2, Hiloa ditch at Hanapepe Falls near Eleele; 3, Kaholalele ditch near Waimea.

Stations Maintained on December 31, 1916.

1, Anahola ditch near Kealia; 2, China ditch near Hanalei; 3, Hanamaulu ditch near Lihue; 4, Hanapepe ditch at Koula near Eleele; 5, Hanapepe ditch at weir near Makaweli; 6, Kamenehune ditch near Waimea; 7, Kanaha ditch near Lihue; 8, Kapahi ditch near Kapaa; 9, Kekaha ditch (makai) near Kekaha; 10, Kekaha ditch (mauka) near Kekaha; 11, Kuna ditch near Hanalei; 12, Lihue ditch near Lihue; 13, Olokele ditch at tunnel No. 12 near Makaweli; 14, Olokele ditch at weir near Waimea; 15, Waimea ditch near Waimea; 16, Wainiha ditch at intake, near Wainiha.

ISLAND OF OAHU.

Stations Established.

1, Manoa ditch, East, near Honolulu; 2, Waiahole tunnel at Government-Bishop Estate boundary, near Waiahole; 3, Waiahole Water Co. Canal at Adit No. 8 near Waiahole.

Stations Discontinued.

1, Ahlo ditch near Kaneohe; 2, Hop Tuck ditch near Kaneohe; 3, Kuou ditch near Kaneohe; 4, Luluku ditch, North, near Kaneohe; 5, Luluku ditch, South, near Kaneohe; 6, Lee ditch near Heeia; 7, Manoa ditch, East, near Honolulu; 8, Reservoir ditch near Heeia; 9, Waipio ditch near Heeia; 10, Waiahole tunnel at Government-Bishop Estate boundary, near Waiahole; 11, Waiahole Water Co. Canal at Adit No. 8 near Waiahole; 12, Wing Wo Tai ditch near Heeia; 13, Wong Leong ditch near Kailua; 14, U. S. Army ditch at reservoir near Wahiawa; 15, Young Mau ditch near Kaneohe.

Stations Maintained on December 31, 1916.

1, Main spring near Kailua; 2, Makawao ditch near Kailua; 3, Makawao spring near Kailua.

ISLAND OF MAUI.

Stations Established.

1, Olowalu ditch near Olowalu; 2, Olowalu ditch near Olowalu; 3, Waiehu ditch, North, near Wailuku.

Stations Discontinued.

1, Olowalu ditch near Olowalu; 2, Olowalu ditch near Olowalu; 3, Waiehu ditch, South, near Wailuku.

Stations Maintained on December 31, 1916.

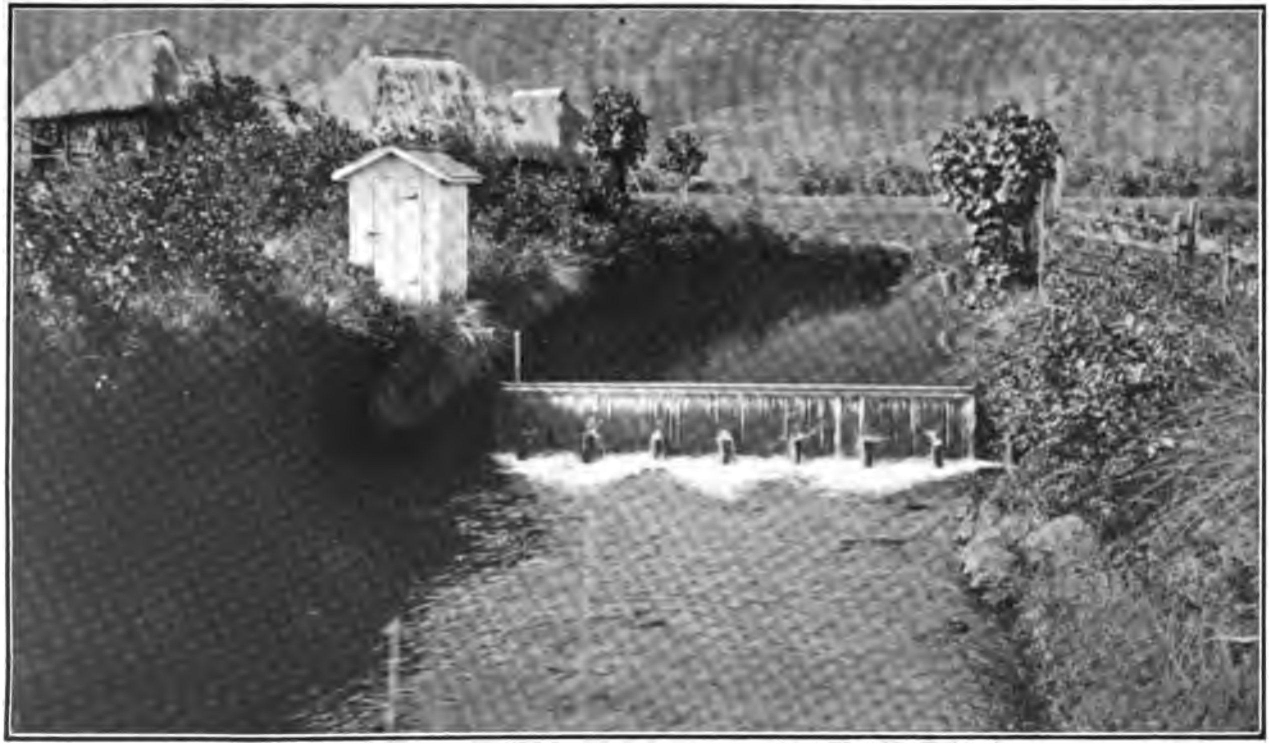
1, Honokawai ditch near Lahaina; 2, Kahoma development tunnel (lower) near Lahaina; 3, Kauaula ditch near Lahaina; 4, Palolo ditch near Waikapu; 5, Olowalu ditch near Olowalu; 6, Waiehu ditch, North, near Waikapu; 7, Waikapu ditch, South Side, Waikapu.

RAINFALL MEASUREMENT STATIONS.

	ISLAND.					Total
	Kauai	Oahu	Maui	Molokai	Hawaii*	
Number of Gaging Stations:						
Maintained on January 1, 1915	34	9	22	....	33	98
Established during biennial period	14	2	1	5	3	25
Discontinued during biennial period	4	2	9	....	9	24
Maintained on December 31, 1916	44	9	14	5	27	99
Total number of stations operated during biennial period	48	11	23	5	36	123

* Includes stations operated in Kona district (North and South Kona, Hawaii, Water Investigation, 1915).

Plate 12.



MEASUREMENT BY 20-FOOT WEIR, KAPAHI DITCH, NEAR KEALIA, KAUAI.

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LIST OF RAINFALL GAGING STATIONS MAINTAINED BY THE DIVISION OF HYDROGRAPHY DURING BIENNIAL PERIOD JANUARY 1, 1915—DECEMBER 31, 1916.

ISLAND OF KAUAI.

Stations Established.

1, Camp No. 1 near Waimea; 2, Kaloko at 725 feet elevation; 3, Kekaha at 9 feet elevation; 4, Kalauea at 325 feet elevation; 5, Koaie at 900 feet elevation; 6, Konohiki at 350 feet elevation; 7, Mana at 10 feet elevation; 8, Mt. Nonou at 370 feet elevation; 9, Olokele at 1,310 feet elevation; 10, Papuaa; 11, Pilaa at 300 feet elevation; 12, Reservoir No. 6 at 400 feet elevation; 13, Waimea at 10 feet elevation; 14, Waialeale at 5,080 feet elevation.

Stations Discontinued.

1, Kekaha ditch intake at 525 feet elevation; 2, Pohakupili at 2,590 feet elevation; 3, Puu Eu at 2,747 feet elevation; 4, North Wailua at 1,200 feet elevation.

Stations Maintained on December 31, 1916.

1, Aakukui at 530 feet elevation; 2, Camp No. 2 at 250 feet elevation, Hanapepe; 3, Camp No. 7, at 150 feet elevation, Waimea; 4, Hanalei at 625 feet elevation; 5, Hanapepe at 530 feet elevation; 6, Hiloa-Manawaiopuna divide at 2,080 feet elevation; 7, Hukipo at 400 feet elevation; 8, Kahana at 3,750 feet elevation; 9, Kaholuamanu at 3,750 feet elevation; 10, Kalihiwai River at 750 feet elevation; 11, Kaloko at 725 feet elevation; 12, Kanaha at 550 feet elevation; 13, Keanakua at 4,450 feet elevation; 14, Kekaha ditch intake at 525 feet elevation; 15, Kekaha at 9 feet elevation; 16, Kilohana at 4,023 feet elevation; 17, Koaie at 900 feet elevation; 18, Kohua Ridge at 3,950 feet elevation; 19, Kokee at 3,550 feet elevation; 20, Konohiki at 350 feet elevation; 21, Lehuamakanoi at 3,932 feet elevation; 22, Lumahai River station at 700 feet elevation; 23, Mohihi crossing at 3,500 feet elevation; 24, Mohihi-Koaie divide at 3,550 feet elevation; 25, Mt. Nonou at 370 feet elevation; 26, Newlun station at 460 feet elevation; 27, Olokele ditch mauka at 2,100 feet elevation; 28, Pali trail at 850 feet elevation; 29, Papuaa; 30, Paukahana at 3,723 feet elevation; 31, Puu Lua at 3,500 feet elevation; 32, Pilaa at 300 feet elevation; 33, Reservoir No. 6 at 400 feet elevation; 34, Sanborn's residence at 105 feet elevation; 35, Waiahi at 600 feet elevation; 36, Waiakoali camp at 3,450 feet elevation; 37, Waialae at 3,600 feet elevation; 38, Waialeale at 5,080 feet elevation; 39, Waimea at 10 feet elevation; 40, Wailua (North) at 650 feet elevation; 41, Wainiha intake at 700 feet elevation; 42, Wainiha power house at 125 feet elevation; 43, Wainiha-Kapaka at 1,123 feet elevation; 44, Wainiha ridge at 1,900 feet elevation.

ISLAND OF OAHU.

Stations Established.

1, Koloa at 550 feet elevation; 2, Punaluu at 300 feet elevation.

Stations Discontinued.

1, Waiahole tunnel at north portal, 775 feet elevation; 2, Waiahole-Waiawa at 2,150 feet elevation.

Stations Maintained on December 31, 1916.

1, Kalihi valley at 520 feet elevation; 2, Koloa at 550 feet elevation; 3, Makaha gulch at 1,300 feet elevation; 4, Manoa at Shingle's residence, 320 feet elevation; 5, Pali at 1,200 feet elevation; 6, Punaluu at 300 feet elevation; 7, South fork Kaukonahua at 1,200 feet elevation; 8, Wahiawa at 940 feet elevation; 9, Wahiawa Water Company's intake at 1,200 feet elevation.

ISLAND OF MAUI.

Stations Established.

1, Olinda at 4,000 feet elevation.

Stations Discontinued.

1, Analoa at 4,100 feet elevation; 2, Camp No. 7, H. C. & S. Co.; 3, Keanae at 1,000 feet elevation; 4, Kopiliula at 1,220 feet elevation; 5, Kihei at 25 feet elevation; 6, Olowalu gulch at 700 feet elevation; 7, Waihee tunnels at 1500 feet elevation; 8, Waikapu gulch at 1,535 feet elevation; 9, Waikamoi at 1,250 feet elevation.

Stations Maintained on December 31, 1916.

1, Eke Mt. at 4,500 feet elevation; 2, Honokohau camp on ridge at 2,300 feet elevation; 3, Honokohau ditch intake at 800 feet elevation; 4, Honokawai at 1,500 feet elevation; 5, Iao Tableland at 1,500 feet elevation; 6, Olowalu at 10 feet elevation; 7, Olinda at 4,000 feet elevation; 8, Penhallow's residence at 390 feet elevation; 9, Puohakamoa at 4,300 feet elevation; 10, Puu Kukui at 2,500 feet elevation; 11, Puu Kukui at 5,000 feet elevation; 12, Waikamoi at 4,200 feet elevation; 13, Wailuku Sugar Co. office at 175 feet elevation; 14, Waiehu at 200 feet elevation.

ISLAND OF MOLOKAI.

Stations Established.

1, Halawa at 1,800 feet elevation; 2, Kamoku at 3,600 feet elevation; 3, Kauluwai at 1,350 feet elevation; 4, Kualapuu; 5, Maunahui at 2,800 feet elevation.

Stations Maintained on December 31, 1916.

1, Halawa at 1,800 feet elevation; 2, Kamoku at 3,600 feet elevation; 3, Kauluwai at 1,350 feet elevation; 4, Kualapuu; 5, Maunahui at 2,800 feet elevation.

ISLAND OF HAWAII.

Stations Established.

1, Honokaa village at 1,100 feet elevation; 2, Old Dairy near Kukaiau; 3, Puu Alala near Honokaa.

Stations Discontinued.

1, Hilo Breakwater at 15 feet elevation; 2, Honokaa village at 1,100 feet elevation; 3, Honokane mauka at 3,800 feet elevation; 4, Hokukano at 2,990 feet elevation; 5, Honaunau at 2,540 feet elevation; 6, Kahaluu at 2,460 feet elevation; 7, Kealakekua at 3,000 feet elevation; 8, Keauhou at 2,610 feet elevation; 9, Kohala pipe line near Waimea.

Stations Maintained on December 31, 1916.

1, Ahualoa homesteads at 2,550 feet elevation; 2, Alakahi-Waipio at 1,030 feet elevation; 3, Alakahi-Waipio at 3,870 feet elevation; 4, Halepiula at 6,000 feet elevation; 5, Hope A, makai, at 4,000 feet elevation; 6, Hope A, mauka, at 5,000 feet elevation; 7, Kaala tanks at 5,500 feet elevation; 8, Kaauhuhu at 1,400 feet elevation; 9, Kawainui (lower) at 1,040 feet elevation; 10, Kawainui (upper) at 4,080 feet elevation; 11, Kemole house near east base of Mauna Kea; 12, Kohala Mt. pipe line; 13, Koiawe at 1,000 feet elevation; 14, Koiawe at 3,350 feet elevation; 15, Old Dairy near Kukaiau; 16, Pohakuloa near Humuula; 17, Puu Alala near Honokaa; 18, Puuanuanu Paddock, west base, Mauna Kea; 19, Puuhinei Paddock, near Huuhinei hill; 20, Punohu Paddock, east side; 21, Puu Kihe at 7,822 feet elevation; 22, Puu Kea at 8,565 feet elevation; 23, Puahala at 6,500 feet elevation; 24, Umikoa-Kukaiau at 3,400 feet elevation; 25, Waima at 980 feet elevation; 26, Kiilae at 2,740 feet elevation; 27, Main weir at 950 feet elevation.

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FORESTRY AS APPLIED IN HAWAII.*

By C. S. JUDD, *Superintendent of Forestry, Territory of Hawaii.*

I. FORESTRY IN GENERAL.

FOREWORD.

The popular conception of the scope of forestry is varied and it is often difficult to disillusionize some minds of the idea that the work of the forester is simply to plant tender seedlings or to enjoy aesthetic ambulations in the green woods, or that the forester is a mere botanist, a landscape architect or a mere orchardist.

LIFE AND QUALIFICATIONS OF A FORESTER.

An old forest officer in India once said: "The life of a forester is not cast on a bed of roses, but rather a bed of thorns. An iron constitution and a good conscience may enable him to surmount all his difficulties."

The experiences encountered in the life of a forester are so numerous and the work which he must undertake in different regions is so varied that it were possible to recount but a small part in this brief paper. His work often takes him into the backwaters of civilization. He must have the capabilities of a Jack-of-all-trades and be able to mix well in frontier communities. From the Igorrote forest guard on his beat in the Philippine jungles wearing his forest badge pinned on to nothing but a gee string, to the forest ranger on snowshoes scaling logs in the woods of Oregon in a temperature of sixteen degrees below zero, the successful forest officer of well rounded experience must have, in a greater or less degree, the faculty to learn quickly new regions, the ability to handle men, the power to think and act in emergencies, the faculty of subordination to authority and of maintaining discipline, and self-reliance.

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* Delivered before the Social Science Association of Honolulu, May 6, 1918.

I am acquainted with rangers in Wyoming who are experts in the cattle range business; I have hiked with rangers through the dense forests on the west coast of Oregon who had never been on a horse, and the ranger in Alaska works in a region where the motor boat takes the place of the saddle and pack horse; hip boots and a slicker, the place of chaps, and it is much more essential that he knows how to adjust a spark plug than to be able to throw a diamond hitch.

PUBLIC SERVICE, THE SLOGAN OF THE FORESTER.

In all his work the forester must bear well in mind the fact that the welfare of the people, not only of the present but of the future, must be his endeavor and that the forest is the medium through which he works.

It has been well said that the successful forester is the one whose life and work contribute most fully to the necessity, convenience, and pleasure of the greatest number of people. Public service, therefore, is the byword of the forester, and it has often been asserted that the forest policy of the National Government is the longest look ahead that the United States has ever taken in any direction.

FORESTRY DEFINED.

To come to a definition of what forestry really is, we may state that it is the science and art of managing forests in continuity for forest purposes, i. e. for wood supplies or forest influences and it is in the latter that we are chiefly interested here in Hawaii.

THE FORESIGHTEDNESS OF FORESTRY.

The central idea of forestry is the intelligent and foresighted use of a great natural resource. Forestry is distinct from arboriculture, which deals with individual trees, for it has to do with single trees only as they stand together on some large area whose principal crop is trees.

SUPPLY FORESTS.

Our civilization is built on the chief product of the forest which from the cradle to the coffin, in some shape or other, surrounds us as a convenience or a necessity. The uses of wood are multifarious and it is safe to say that 99 per cent of all wood is used in supplying real needs.

Over half of the people in the United States live in wooden houses and the houses of the other half require wood as an indispensable part of their construction. More than two-thirds use wood as fuel and for every 100 tons of coal mined, 2 tons of mining timber are needed. There is hardly a utensil, a tool, or even a machine, in the construction of which wood has not played a part, were it only to furnish the handle, or the mould or pattern. Even with the increased substitution of steel, concrete, brick, and tile, for wood, there will always be need for all the wood that can be grown in the United States, where the annual consumption per capita is 260 cubic feet which is ten times that of France. This consumption for many years has been far in excess of the growth, hence the strong demands on the forests for wood.

Water, also, may well be considered as another product of the forest which is of vital importance to mankind. "But the intimacy of the relation of the forest to the daily life of the individual now, is as nothing compared to what it will be when the coal, oil, and gas are exhausted; when our great source of power and heat comes, all of it instead of a part of it, out of the forest, and when the daily life of every man is intimately affected by the resources, revenues and utilities produced by electricity derived from water flowing out of the forests."

PROTECTION FORESTS.

Apart from their intrinsic productive value as briefly outlined above, to maintain which in perpetuity, the practice of forestry is essential, the forests have an influence generally beneficial to a country. They act as equalizers of the flow of streams by diminishing in general the frequency and violence of freshets and increasing the low-water flow and by preventing erosion of the soil. Recent investigations in India have shown that forest denudation is highly injurious to regulated stream-flow. In the United States on account of forest denudation at the headwater of streams it is estimated that one billion tons of the most fertile soil on the most fertile land in the country goes annually into the ocean. This is one of the largest losses that the nation suffers.

PREVENTION OF RUNOFF.

The forest is one of the most effective means of preventing erosion for it protects the soil and stores the water. The force of the rain is broken by the trees, the underbrush, and the litter on the ground so that it does not beat upon the soil. Much of the precipitation reaches the earth by running down the twigs and branches. In a heavy rain the water drips down so quietly as to have practically no beating effect upon the soil. There is no perceptible surface run-off until great quantities of rain have fallen. Instead, the water is soaked up by the organic matter or humus in the upper layers of the soil and as the rain falls it is absorbed by this sponge-like ground cover, is then passed on to the reservoir of mineral soil beneath and finally fed out gradually to the springs and streams. The surface run-off is also checked by the mechanical obstruction offered by stumps, fallen twigs, moss, and branches, and even whole trees and percolation of the water into the soil is made easier by the network of small roots and the channels left by the decay of large roots. Such is the beneficial influence of forests on run-off.

INFLUENCE OF FORESTS ON CLIMATE.

Other forest influences of a beneficial character exist but are difficult to measure. The effects of forests on climate have been studied in Europe and while ideas as to the elements which enter into the problem have been cleared up, the real object of inquiry has not yet been finally solved because methods of meteorological inquiry and instruments are as yet unsatisfactory. For instance, rain-gages may register amounts varying from 7 to 40 per cent according to their construction and position and the character of the wind and rain during the same storm. The problem is too complicated for our present means to be settled by the mathematical method.

It has not yet been proven that forests produce rain. Because of this inefficiency of mathematical measurements, we are thrown back on the method of general observation in the field and the conclusion has been that the tendency of a forest cover is to reduce extremes of high and low temperatures and, on account of its cooling effect, to keep the air within the forest and that above it, nearer to the saturation point and as a consequence it might occur that moisture bearing currents passing over would precipitate their moisture more readily above or near the forest growth.

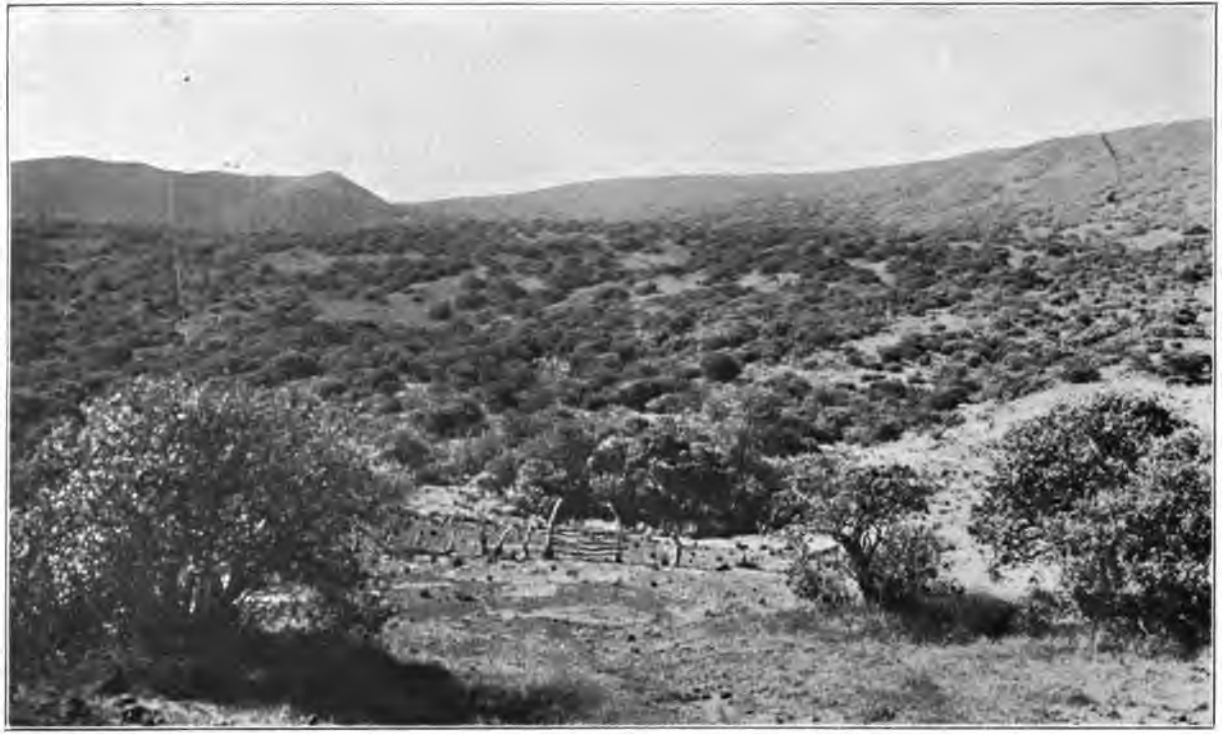
The forest, however, positively acts as a windbreak by breaking the velocity of dry winds and possibly enriching them somewhat with moisture and reducing the rate of evaporation over a neighboring field. It also acts as a protection against cold winds.

As far, then, as forest influence on climate is concerned, we must admit that no satisfactory conclusions have positively been reached excepting as to this favorable wind-break effect. It is reasonable to assume, however, that wholesale forest destruction and removal must change the climatic conditions of the denuded area.

VALUE OF FOREST FOR RECREATION.

There are other beneficial and indirect forest influences of minor importance and one of these, which must not be overlooked in our modern economy of city life, is "the recuperation of bodily energy and of spirit which an occasional sojourn in the cool, bracing, and inspiriting forest air brings to the weary dweller of the city. This is an element in the general health conditions of a people which must not be neglected."

"From every point of view the forest is one of the most helpful friends of man and perhaps no other natural agent has done so much for the human race and at the same time has been so recklessly used."



THE MAMANI TYPE AT 7500 FEET ELEVATION ON THE NORTH SLOPE OF MAUNA KEA, HAWAII.

EVOLUTION OF FORESTRY.

"The history of the forest in all forest countries shows the same periods of development.

"First, hardly recognized as of value or even as personal property, the forest appears as an undesirable encumbrance of the soil and the attitude of the settler is of necessity inimical to the forest; the need for farm and pasture leads to forest destruction.

"The next stage is that of restriction in forest use and protection against cattle and fire, the stage of conservative lumbering. Then some positive efforts to secure regrowth by fostering natural regeneration or by artificial planting: the practice of silviculture begins.

"Finally, a management for continuity—organizing existing forest areas for sustained yield—forest economy is introduced."

NEED OF FORESTRY.

It has been said that the longer a country is inhabited, the poorer it becomes in forest growth and water. Private interest, private enterprise, as a rule knows only the immediate future, has only one aim in the use of the forest, viz: to obtain from it the greatest possible personal and present gain. A lumberman is a dealer in trees, with an eye to present profit and comparatively small regard for future conditions. A forester, on the other hand, aims to keep the land productive, to treat timber lands so that they will produce continuous crops of wood. This policy necessitates some present money loss and calls for the avowed intention of holding land as an investment.

The protection of the interests of the aggregate against those of the individual necessitates government control whenever a communal interest would suffer by the unrestricted exercise of individual rights.

This necessity was felt early in the world's history but it was not until about 1359 that forestry really began to be practiced in continental Europe. Forest protection and methods of silviculture were put into effect which involved the proper age at which timber should be cut, methods of thinning and of securing reproduction both naturally and by replanting. The science of determining the rotation for the production of wood has now been so far advanced that for the past 150 years timber has been raised in the same manner as any agricultural crop and it has been possible by growth and yield studies to predict centuries in advance just what the future wood crops will be.

HISTORY OF FORESTRY IN THE UNITED STATES.

The United States was slow to take up forestry because it was confidently believed that the forest resources in the vast stretches of country in the middle west, south, and far west were inexhaustible.

But the increasing floods and the shortage of wood in some places by the conversion of heavy virgin forests into stretches of waste land made the people finally wake up to the fact that something had to be done before it was too late.

The first real forest legislation was in 1876 and in 1886 a Division of Forestry was created in the Department of Agriculture. In 1891 the President was authorized to establish forest reserves and many were set aside but were indifferently managed with an inefficient force.

In July, 1910, this Division became the Bureau of Forestry, and in March, 1905, changed its name to the Forest Service. At this time it also took over from the Interior Department the reserves which they then began to call National Forests. Many of the States also took up forest work accompanied by necessary legislation. Private interests placed many stumbling blocks in the progress of forestry which was made difficult because of the fact that three-fifths of the standing timber had already passed from government control into private hands, but the present system of National Forests which were created to produce a perpetual supply of timber for home industry, to prevent destruction of the forest cover which regulates the flow of streams and to protect local residents from unfair competition in the use of the forest and range, is a monument to those far-sighted men such as Pinchot who fought hard and valiantly in the early days to place the whole National Forest enterprise on the basis of permanence.

NATIONAL FOREST ACTIVITIES.

The net area of National Forests now owned by the people is over 150 million acres and the activities of the Forest Service extend from the Atlantic States to the Pacific Coast from Mexico to Alaska and an efficient organization has gradually been built up to handle the work of protection of the Forests and the development of their resources.

In only twelve years the National Forests have been extended to cover an area more than four times that of all the forests of the German Empire and the Forest Service has won the respect and confidence of the body of right-minded people all over the West as well as the East.

The average area administered by a Forest Service Ranger on a National Forest is over 140 times greater than the area administered, until recently, by a man of equivalent rank in a German forest.

The activities of the National Forest force cover a wide scope and extend from protection against forest fires, which is always considered the work of paramount importance, to the construction of thousands of miles of roads, trails and telephone lines, the extensive planting of trees to reestablish forests destroyed in part by fires, the carrying on of research and experiments to aid in the development of the best methods of forestry, the survey of forest resources, classification and segregation of agricultural land, the selling of mature timber and the improvement of grazing areas in certain forest regions where the supply of water is not involved by regulated allotments of the herds.

An appropriation of ten million dollars to become available at the rate of one million a year was recently made by congress to develop roads within the National Forests and the importance of having public forests at the headwaters of important streams was recognized and greatly emphasized through the appropriation in 1916 of three million dollars for continued purchases of forest lands begun under the Weeks Law.

In this manner a vast area on the mainland is now managed with a view to the most general, varied and harmonious use. Through successful administration the permanence of the National Forests is becoming more and more assured and they are now a vital part of the economic life of the regions which use their resources.

THE VALUE OE FORESTS IN MODERN WARFARE.

A few words on the part that the forests and the United States Forest Service are playing in the present war and then we shall come down to forestry in Hawaii.

In this age of coal and iron, wood and other forest products which have almost innumerable uses in modern warfare are being sought more eagerly and used more extensively than ever before. In the trenches, on the road, in the air, in the shipyard, in the munition factory and chemical laboratory and in the building of cantonments, wood has become a dominant factor and never before has the demand for exact knowledge on the quality and uses of wood been so urgent.

In modern warfare forest products are needed in large quantities. The average trench requires alone about one cubic foot of wood to 10 feet of trench or about 60,000 board feet to the mile or 15 billion feet to the French front exclusive of that required for shelter, artillery screens, block houses and fuel.

Forest industries which were on the decline or entirely abandoned have been revived by the war and new uses for wood products developed.

Wooden ships and airplanes call for special materials. Sitka spruce, once a despised material, is now found almost indispensable for airplane construction furnishing long, clear, light, yet strong material in which failure is far less common than in the metal parts. In fact, the demand for spruce wood is now so great that a spruce-production division of the Signal Corps has been formed of 10,000 men to get this needed commodity from the woods to the airplane factories.

About 200 board feet of wood is used in the actual construction of the average airplane. To obtain this material it is ordinarily necessary to work over about 1500 feet of select lumber which often represents all that can be used for airplanes of 15,000 board feet of standing timber.

FORESTERS IN WAR WORK.

The forest products laboratory of the Forest Service at Madison, Wisconsin, has been of the greatest assistance to the War Department in solving many of the problems which have arisen from the increased use of wood, especially in connection with its seasoning for aircraft material and much assistance has also been given to hardwood distillation plants in order to increase the production of acetone and other products needed for munition making.

A forest school classmate of mine, who is now Assistant Director of this laboratory, recently wrote me as follows:

"The Laboratory seems to have the confidence of the War Department and problem after problem having to do with wood is being referred here. Our force has been increased 100 per cent. Practically all work is war work. We are working at high tension; some of the sections are working double shifts because we can't turn out the work as fast as it is referred to us. While the desire to get into one of the Forest Regiments was strong within me, I am getting some mental compensation out of the fact that I am engaged here wholly on work of a national defense character."

Of men, the Forest Service and the lumber industry have contributed thousands who have been over in France now for some time helping the Allies in cutting and getting out timber, lumber, and other material for the use of the armies and in building railroads, roads and bridges.

Forester Graves was one of the first to go over to make arrangements for this work and has recently been promoted to the rank of Lieutenant Colonel. He was soon followed by the first regiment of woodsmen numbering about 1200 men and designated as the Tenth Engineers (Forest). Over 300 qualified foresters and lumbermen have been commissioned to serve as officers for these forest battalions and of these two-thirds are practical lumbermen or saw-mill operators and one-third are trained foresters with long woods experience. The second regiment called the Twentieth is now being formed and will be the biggest regiment in the world.

II. FORESTRY IN HAWAII.

It is a far cry from the battle front to the mountains of Hawaii, but it is here that are found the forests, which conserve the water, which irrigates the cane, which produces the sugar, which goes to feed the armies over seas and the many people contributing to their support.

NATIVE HAWAIIAN FOREST AT MOKULEIA, OAHU.
Kukui type in foreground, ohia lehua type in background.

EXTENT OF THE ORIGINAL FORESTS.

Originally the Hawaiian forests were limited no doubt only by such natural conditions as lack of rainfall, elevation, and lava flows. The extent of the original native forest is not known, but that it was much greater than at present is certain from the scant evidence that remains. Shells of land molluscs found on Niihau in a subfossil state indicate a once heavy forest and considerable moisture on that island. The forests on Kauai came much further down than they do at present and on Oahu the Leilehua plateau between the Waianae and Koolau ranges was no doubt once densely forested. The few insects, peculiar to boggy uplands, found on the higher forest region on Lanai indicate that there was once a boggy region similar to the wettest part of Molokai. On Molokai and Lanai there was evidently a considerable growth in the early days of koaia and koa on the lower slopes below the elevation of 2000 feet, but these have been killed out entirely on Lanai and only a few scattered koa trees remain on Molokai outside the limits of the true forest.

Even in the region on the dry lower slopes of the leeward side of the islands, where the algaroba is now predominant, there was once more or less open forest land, for Perkins tells us that passerine birds regularly descended into the clumps of trees of this open country and from there even, in Cook's time, they passed still downwards and several species were found frequenting the coconut tree on the beach.

PRESENT FOREST AREA.

The present area of original forest lands in Hawaii through various agencies has been reduced until now it covers approximately only 800,000 acres or 20% of the total land area, two-thirds of which is under government control.

This record of forest destruction is beaten only in countries or islands of very dense population such as Porto Rico, for instance, which was once completely forested but on which the virgin forest area has been so materially modified by the acts of man and beast during several centuries that it is now reduced to only 2 per cent of the total land area.

The destruction of the Hawaiian forest in the past was deplorable, but that it should continue in the present for one reason or another seems inexcusable.

FOREST TYPES IN HAWAII.

As we find them today, what remains of the Hawaiian forests together with the forest of introduced trees, may be divided for the purpose of convenience in forest management into forest types. Technical botanists have classed the Hawaiian flora into different groups or zones based on physical features mostly of elevation. Hillebrand gives us five of such zones; the lowland, lower forest, middle forest, upper forest and the bog zone, and Rock has added to these one more, the strand type or zone.

In the following classification the bog zone is omitted altogether since it cannot be considered a forest type on account of the general absence of trees, and the several types are named, as is customary, after the most striking tree which is characteristic of the region. This classification is admittedly rough and several species such as the ohia and naio which occur from sea level up to 7000 feet will be found in one or more types and in places the key tree may sometimes be lacking. But these types will readily be recognized in the field and will serve the general purpose of the forester.

For convenience in forest management then, we have the following four main forest types:

1. ALGAROBA TYPE, *Prosopis juliflora.*

This corresponds more or less to the lowland type of the botanist, and in it the introduced algaroba is now the predominant tree in most regions and particularly on the leeward side of the islands. In it are also found the hau, hala, and prickly pear and, near the shore, the kamani, milo and coconut. This type is usually found from sea level up to 1000 feet.

2. KUKUI TYPE, *Aleurites moluccana.*

This corresponds in situation to the lower forest type of the botanist, and in it the kukui strikes the eye as being the predominant tree in most situations, more especially in valleys and lower slopes.

On the windward side of the island the trees in this type constitute a wetter forest than on the leeward side and often koa occurs in it and ohia ai, and shrubs such as ki, ape and ginger and the ieie vine.

On the leeward side where more xerophytic conditions occur, the kukui is confined more closely to the moisture gulches and we find in addition a great wealth of dryland trees among which the ohe, wiliwili, halapepe, and olopua are leading species. In fact, it is in this type on the leeward side of the island that, according to Rock, 60% of all the species of our indigenous trees are found. It is interesting to note that with the exception of four or five trees, such as the wiliwili, which have light, soft wood, and thin bark, all of the trees in this type in the drier situations, have hard, close-grained wood and thick bark. This type is found between the elevations of about 1000 feet to 2000 feet.

3. OHIA LEHUA TYPE, *Metrosideros collina polymorpha.*

This corresponds to the middle forest zone of the botanist and constituting our "rain" or water-producing forest is consequently the most important type. Ohia lehua attracts the eye as the most predominant tree although almost pure stands of koa and a variety of other trees may be found in it. This type is found usually between the elevations of 2000 to 5000 feet.

4. MAMANI TYPE, *Sophora chrysophylla.*

This type occurs above the ohia lehua type but only on the islands possessing the higher elevations of from 5000 to 10,000 feet. It corresponds to the upper forest zone of the botanist and in it may be found almost pure rather open stands of mamani with also some naio and occasionally koa and ohia.

VALUE OF THE FOREST TYPES.

From the viewpoint of forest management, the value of these four types may be described as follows:

1. ALGAROBA TYPE. A commercial or supply forest useful mainly for the production of algaroba wood, and beans for stock feed, and blossoms for bee pasturage. In this type other introduced trees may also be grown for fuel and timber.
2. KUKUI TYPE. A protection forest, valuable chiefly in the scheme of water conservation as a protection to the ohia lehua type immediately above and also for the production of wood in its lower parts.
3. OHIA LEHUA TYPE. An absolute protection forest, because generally it is water producing and therefore the most important. It should be left strictly alone without interference by man or beast.
4. MAMANI TYPE. A protection forest, valuable chiefly for its protective influence on the ohia lehua type immediately below. In a minor way it may some day be considered in parts a supply forest for the production of planted commercial timber.

CHIEF VALUE OF THE HAWAIIAN FOREST.

It may readily be seen from the foregoing classification that the prime value of the main Hawaiian forest types lies not in their commercial wood products but in their ability to serve as a protection to the watersheds of streams and springs needed for irrigation and domestic purposes and to watersheds tributary to artesian basins and in their beneficial forest influences in regions where the people depend mainly upon the rainfall for their water supply.

That these forests are intimately connected with the leading industry in the islands—sugar production—through the water which they conserve, may readily be seen from the fact that of the total of 649,786 tons of sugar produced in the 1917 crop on an aggregate area of 120,251 acres, 62% of the tonnage was secured from irrigated fields covering 62,979 acres. In addition to actual irrigation, these forests supplied water for domestic purposes, for the development of electrical energy for pumping and, in the unirrigated regions, water for fluming cane.

FOREST PROTECTION THE CHIEF WORK.

The chief value of the forest in the last three types, therefore, is the effect which it has on the supply of water, and the industries of the Territory demand that it be managed chiefly as a protection forest. Forestry in Hawaii therefore is chiefly concerned with forest protection.

The feasibility of treating the native forest on the leeward side of the island of Hawaii, where there are no permanently running streams, as a supply or commercial forest, has been advocated and attempts have been made to utilize the mature timber in these forests by manufacturing it into ties and lumber and placing it on the market. That these attempts have resulted in failure is in my opinion fortunate, for although the plan of exploiting this forest included a scheme for immediate reforestation after logging so as to keep a forest on the land, I believe that our knowledge of the treatment of this forest so as to insure a second crop either naturally or artificially is as yet so imperfect, that it is far safer to preserve it in its original form.

The practice of forestry in the three main types of forest should therefore continue to be forest protection. Forest planting for the production of fuel wood and timber in the lower part of the kukui type, as well as in the algaroba type, is proper, has been going on for some time, and may be continued on selected areas without detriment to the main purpose of this type, provided the land is continually kept in forest by coppice growth or by replanting immediately following cutting. Forest planting also for the production of lumber may be done in the mamani type provided this same course is followed.

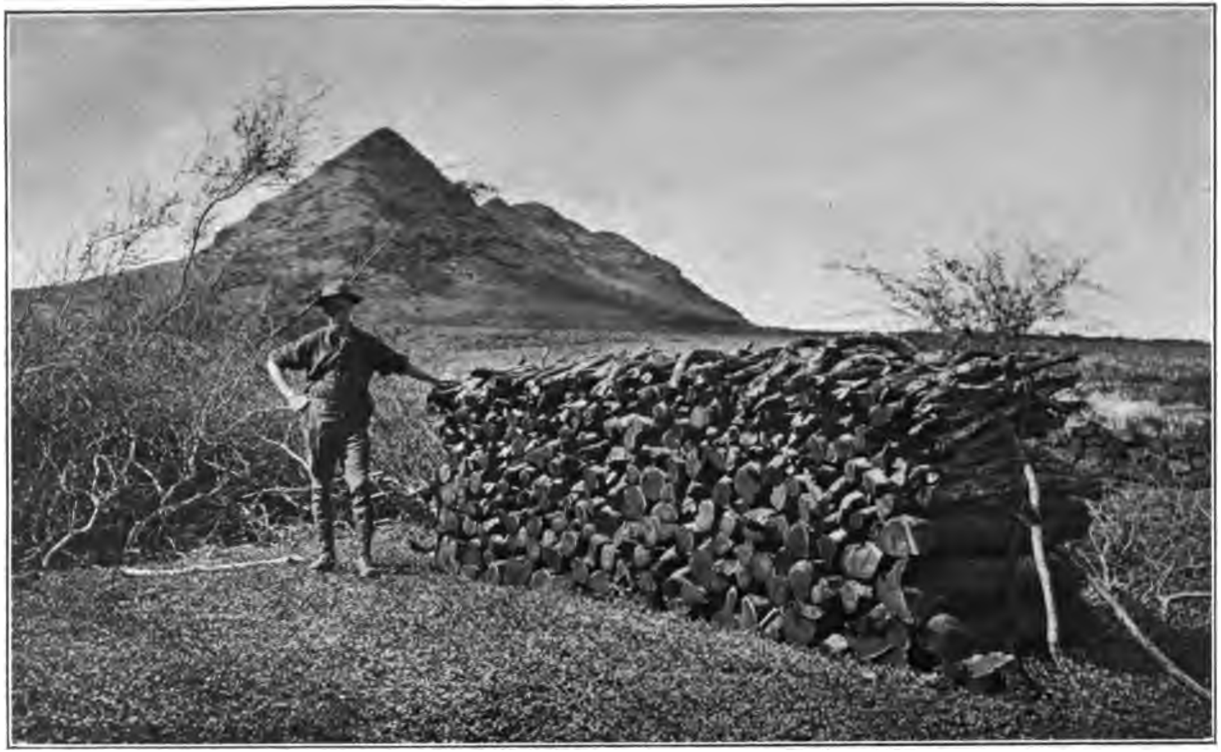
HISTORY OF FOREST DESTRUCTION.

But continued efforts must be made in the work of forest protection to prevent the further destruction of deleterious agencies which have wrought havoc in the native forest in the past and to build up the forest and restore it to a condition of greatest usefulness.

These destructive agencies probably began with the sandalwood trade when the woods were stripped of this valued tree but the first serious damage began as far back as 1815 when cattle became so abundant that they penetrated the accessible forests and gradully worked their way year by year further back into the native jungle.

The susceptibility of the Hawaiian forest to injury by cattle is too well known to need description here. The combination of trees, undergrowth, vines and ferns is ideal for the conservation of water, but this combination is not able to stand up against the onslaughts of cattle grazing. You must have either the indigenous forest intact or allow cattle in the forest until it dwindles down finally to nothing but a waste of dead trees and Hilo grass producing no steady supply of water.

Goats have also done their share in this forest destruction. Insects have attacked the trees in their weakened condition, introduced grasses have been spread by stock and have prevented the forest from renewing itself by natural reproduction and what damage has not been done by these agencies, has been accom-



Fuel Wood Cut in the Algaroba Type, Lualualei, Oahu.

plished by destructive fires which have followed long dry spells and by man who has drawn upon the native forest for his firewood. All of these have worked tooth and nail until it is a wonder that we have left a forest of any value.

GRAZING MOST DETRIMENTAL TO NATIVE FOREST.

The continued grazing of cattle today in the native forest for the pecuniary benefit of a few to the detriment of the future welfare of the chief industry of the islands and of the community is very short-sighted. If this one element of damage were removed once and forever, a great deal will have been accomplished for forest protection in Hawaii. Much good work along this line has of course been done, but as a rule it has not been started until the shoe has begun to pinch, until the scarcity of water for fluming or other purposes has made it imperative that the remaining local forest be protected. With the cattle excluded from the forest once and for all by proper stock-proof fences, appropriate steps could then be taken toward getting the forest back into a satisfactory normal condition for water conservation by a careful study and solution of the problems which confront us.

PROTECTION OF CITY WATERSHEDS.

Right here I wish to digress to the subject of the protection of city watersheds by excluding not only cattle and other stock but also human beings. This is a practice, the necessity of which is becoming more apparent on the mainland, but when in 1916 a rule which forbid trespassing on the Honolulu watershed in Nuuanu Valley was passed by the Board of Agriculture and Forestry various protests were then and have continued to be voiced by those who place their own personal pleasure above the health of the community and sanitation of the city.

The city of Portland, Oregon, enjoys a continued abundance of the purest mountain water in the world, and this is assured only by the absolute forbidding of all trespassing on the Bull Run watershed which was set aside by act of congress in 1892. This comprises an area of 18 miles by 22 miles, in extent, containing 142,080 acres, or little smaller than the combined areas of Lanai and Niihau.

It will probably be advisable in the near future to place other watersheds in the Territory under a similar rule and for the same purpose.

FOREST DETERIORATION DUE TO OTHER CAUSES.

Another phase of the deterioration of the native forest has recently been discussed and this involves changes in soil conditions. It has been asserted that our present flora is a new-soil flora which is not able to persist on old soils; that our native forests are doomed and are dying out so rapidly that within 50 years or more they will have no value whatsoever as protective coverings for our watersheds; and that the only solution is to replace the native flora by introducing new plants.

Personally, I cannot take such a gloomy view of the situation but feel confident that when given adequate protection from further injury by man and beast, the native forest in most regions will in large measure come back of itself, although it may be advisable to supplement the process with introduced species, carefully suited to the situation by adequate tests.

On the mainland in the eastern states the chestnut blight has within the past few years wiped out practically all of the chestnut trees. In the west it has been asserted that the dendroctonus beetle does as much damage annually to the pine trees as do forest fires, but other trees take their places and a satisfactory forest is still there.

To me it seems foolish to predict the extinction of the native forest in such a brief space of time as 50 years. It is well known that the flora of the islands as a whole contains a much larger proportion of endemic plants than that of any other country of the same size and that the richness in endemic species stands in the same ratio as the age progression of the various islands which is from east to west. The flora of Mauna Loa on the newest land, which indeed is still in the process of formation, is the poorest and most uniform, while Kauai, the oldest island geologically, is not only the richest in species but also has them on the whole more differentiated.

Volcanic activity in the Waianae Range on Oahu according to Doctor Sereno Bishop ceased at least 700,000 years ago and from evidence of extinct Eocene fossils found in the elevated coral reefs, this volcanic extinction probably occurred much earlier, since the dawn of Eocene time is placed by geologists at four million years ago. It is reasonable to assume, therefore, that Kauai, which is older than Oahu, had forest growth on it at least half a million years ago. If our native forest belongs to a new-soil flora and is unsuccessfully trying to persist on old soils, and soil conditions are changing so rapidly on Maui, for example, that aside from injuries done by man and beast, in 50 years there will be no native forest left, it appears to be rather remarkable that we still find any forest at all remaining on the much older soils of Kauai.

From evidence in the wet forest region of Molokai and other places where the native growth has come back wonderfully as a result of complete protection against stock, I believe that the balance of native forests if given this complete protection will continue to serve their purpose as water conservers for many many years after we and our descendants have been forgotten.

FOREST PROTECTION MUST BE SUPPLEMENTED.

The problem of getting the native forest back to normal, however, is not simply a matter of protection against damage. It involves other features on which a great deal of experimentation must take place before the cheapest and most satisfactory methods are determined.

GETTING RID OF THE HILO GRASS IN THE FOREST.

One of these problems is getting rid of Hilo grass which has followed cattle grazing into the forest and which prevents natural reproduction of our native forest trees. Not only cattle but pedestrians have been responsible for carrying the seed of this forest pest into the innermost sections of the Hawaiian woods. There is hardly a foot of the trail from the Waiahole tunnel over the Koolau Range to Waiawa Valley which does not now contain Hilo grass which has sprouted from seed carried on the shoes and trousers of those who have walked over the trail. It may become advisable in the future to stop all travel in the native forest to prevent this one thing alone.

In order to get rid of the vast stretches of Hilo grass now found on the borders of or within the native forest, as a preliminary to reforestation, it will likely be necessary to expend considerable money. What seems now to be the most feasible method of accomplishing this is one which is in vogue in the Philippines where over 40% of the area of the islands is covered with cogon grass which is not only useless for grazing and destroys the productivity of the soil in which it grows, but is a fire menace and, worst of all, is the breeding place of the destructive locusts which yearly swarm over the islands. This method is to burn the cogon grass just before the rainy season and broadcast the seed of the Ipil ipil, *Leucaena glauca,* which is also common in these islands where it is known as haole or false koa. It has been found that this small tree will not only kill out the cogon grass within two years, but increase the value of the soil by the fixation of nitrogen and remedy the toxic effects produced by cogon so that reforestation may proceed. No doubt many Hilo grass areas in Hawaii could well be reclaimed by a similar method.

TREE INTRODUCTION.

The introduction and dissemination of exotic trees, shrubs, vines, and other plants to supplement our native flora must evidently be done in the most careful manner so as to avoid the establishment of any new pest such as the lantana. The introduction of the different species of banyan of the genus *ficus* has been advocated, but it has not yet been proved that they are entirely suitable for our wet forest region. It is questionable whether the desired lower story of bushes, ferns, and undergrowth will come up under their dense shade and if their natural spread is facilitated and hastened by the introduction of a flower-pollinating wasp, it is not certain that they will not become a pest in localities where they are not wanted.

PRECAUTION SHOULD BE EXERCISED.

It is imperative, therefore, that the greatest of care be exercised in the work of plant introduction for the replenishment of the native forest. A few successful and proper introductions will be much more valuable than a heterogeneous accumulation of plant pests. The Division of Forestry has been working along this line and has done what it could with its limited facilities but is yet not prepared to announce with confidence many tree introductions which are absolutely reliable for this purpose.

OTHER PHASES OF FORESTRY.

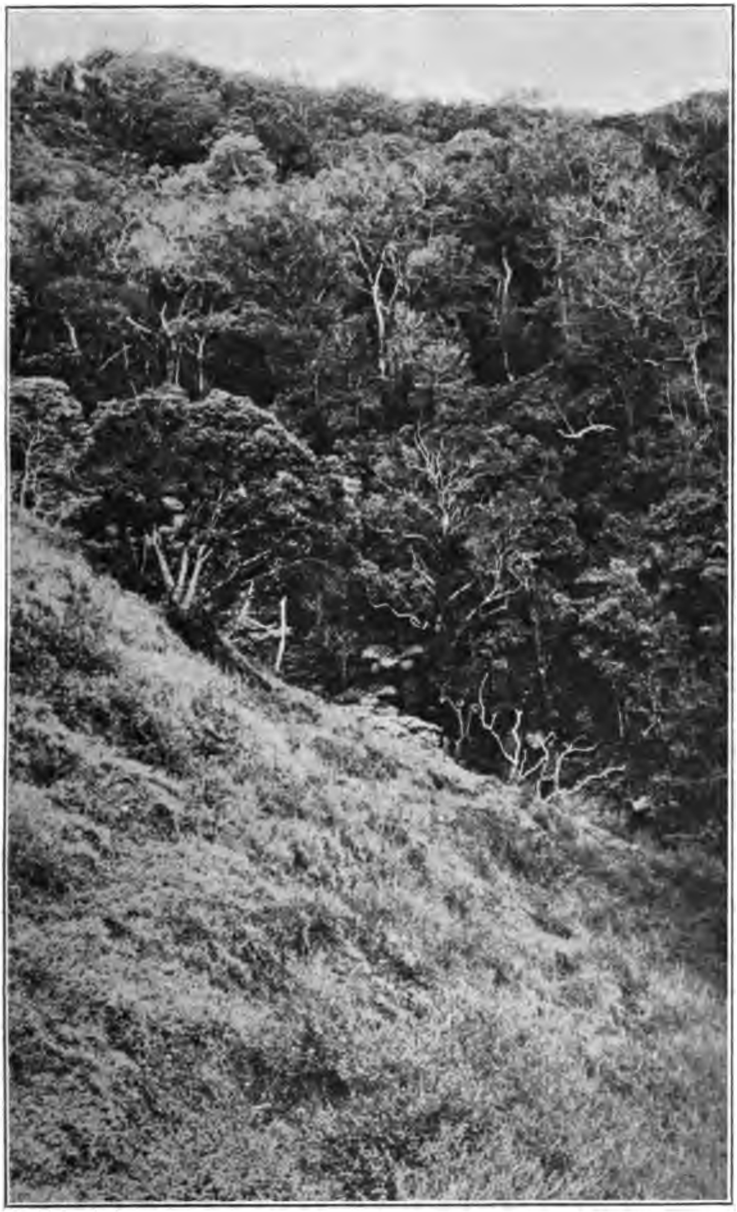
Other phases of forestry in Hawaii could be mentioned, if time permitted. Among these is the treatment of the algaroba forest which is susceptible of true forest management on a regular rotation. The work of thinning the algaroba to increase the yield of pods and bee pasturage is true forestry and much more along these lines could readily be accomplished. The work of planting trees for the production of fuel wood and timber which is now carried on at the rate of about 1,000,000 trees annually, largely by private interests, is true forestry which produces comparatively early returns.

PRESENT STATUS OF FORESTRY IN HAWAII.

The history of government forest work in Hawaii is familiar to most of you. Except for some introduction and tree planting work which was performed by the government previous to 1903, and the protection of certain forest areas by private owners, the real forestry movement began with the creation of the Division of Forestry under the Board of Agriculture and Forestry. The principal work of this Division in the past has been the demarcation and setting apart of forest reserves and the raising and distribution of trees for planting. The first has almost been completed so that now there are 39 reserves having a total area of about 772,000 acres of which 68% or over half a million acres is government land.

THE FOREST RESERVES.

According to the forest axiom that all land should be put to its highest use, the boundaries of these reserves have been drawn so as not to interfere with revenue-producing land or areas which may be developed for agriculture except where stream protection and forest influence are unquestionably more important. In other words, the present forest reserve land is confined as closely as possible to areas which are not suitable for any greater economic use. It would have been better had the reserves originally included more land so as to secure the protective benefit of woodland belts above and below them. To make appreciable reduc-



SLOPE DENUDED OF FOREST BY CATTLE AT MOKULEIA, OAHU. Heavy native forest in background protected from the ravages of stock by a steep gulch.

tions in any of the forest reserve areas on the plea of increased stock production or on other grounds, would be disastrous to the main purpose for which they were created. Where adjacent private lands are involved in these reserves, the proclamation creating reserve applies to them only in the nature of a recommendation that such private lands be protected and held by the owner as a forest reserve. In some cases, such lands have under the law been turned over to the care and control of the Division of Forestry. In others, the owner has given them adequate protection. In still other cases, the opposite has unfortunately been true.

FOREST RESERVE ADMINISTRATION.

Of recent years, an attempt has been made with the available facilities to take these reserves out of the class of "paper reserves" and to place them under true forest administration and protection. On almost 50 miles of reserve boundaries fences have been built or repaired where it was necessary to keep stock from the native woods. The Division of Forestry is always ready to meet the adjacent owners half way in the cost of co-operative fences. A comprehensive regulation against trespass on the reserves has been passed and is enforced along with other regular work of fence building and repairing, tree planting, and patrolling for forest fires in the dry season, by six forest rangers who are constantly on duty so that each main island now has at least one forest ranger to look out for the government's interests in the reserves.

WATERSHED PLANTING.

In reforestation, special attention has been given to the planting up of watershed areas. Upper Nuuanu received early treatment and more recently the government reserve lands in Manoa and the Makiki Valleys have been reforested with native species, mostly koa and kukui, with great success.

CONCLUSION.

In the Territory of Hawaii public sentiment is fortunately favorable on the whole to forestry with good reason. It remains to give this sentiment still further substantiation by fortifying the efforts of the Territorial Government in protecting and bringing back to normal on private as well as on government lands the forest which conserves and maintains the agricultural life blood of the land. To do this, concerted action is necessary and is confidently expected.

HAWAII AGRICULTURAL EXPERIMENT STATION,
J. M. WESTGATE, Agronomist in Charge,
Honolulu, Hawaii.

Under the supervision of the STATES RELATIONS SERVICE,
Office of Experiment Stations, U. S. Department of Agriculture.

REPORT OF THE HAWAII AGRICULTURAL EXPERIMENT STATION.

1918.

Issued April 10, 1919

WASHINGTON
GOVERNMENT PRINTING OFFICE
1919

HAWAII AGRICULTURAL EXPERIMENT STATION, HONOLULU.

[Under the supervision of A. C. TRUE, Director of the States Relations Service, United States Department of Agriculture.]

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LETTER OF TRANSMITTAL.

HAWAII AGRICULTURAL EXPERIMENT STATION,
Honolulu, Hawaii, July 15, 1918.

SIR: I have the honor to transmit herewith and to recommend for publication a report of the Hawaii Agricultural Experiment Station, 1918.

Respectfully,

J. M. WESTGATE,
Agronomist in Charge.

Dr. A. C. TRUE,
Director States Relations Service,
U. S. Department of Agriculture, Washington, D. C.

Publication recommended.
A. C. TRUE, *Director.*

Publication authorized.
D. F. HOUSTON,
Secretary of Agriculture.

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[1] Resigned June 30, 1918.

[2] In military service.

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REPORT OF THE HAWAII AGRICULTURAL EXPERIMENT STATION, 1918.

SUMMARY OF INVESTIGATIONS.

By J. M. Westgate, *Agronomist in Charge.*

INTRODUCTION.

The continued world food shortage of the past year revealed more clearly than ever the great dependence of the population of Hawaii on imported food products. Any interruption of shipping under such conditions immediately causes a severe disorganization in the distribution of food products. This has served to emphasize more and more the need of a greater production of locally grown foods. What the islands need most in an economic way is the development of diversified industries to provide a surplus of edible manufactured products which can serve as articles of export during normal times and which in times of dire necessity can be readily utilized to feed the local population. Sugar can be used only to a very limited extent to replace the starches in the human dietary, but, were such an industry as the manufacture of tapioca from cassava successfully launched, the cassava starch and flour could readily be utilized as food whenever necessary.

EMERGENCY WAR GARDENS.

Throughout the year, especial attention has been given to the development of the war-garden idea among those who became interested in doing something practical along food production lines. The station has continued to allot small plats of otherwise waste land to its laborers for the purpose of enabling them to maintain demonstration war gardens to serve not only as sources of foodstuffs but also as object lessons to the public, several of these gardens being located immediately in front of the station buildings. The gardens have also provided opportunity for successful demonstrations of the efficiency of spraying to overcome various insect and plant disease pests which are always troublesome under local conditions. The station has continued to supply cuttings, roots, tubers, seeds, and seedlings of such food plants as have not been regularly carried on the local market. It has also been freely consulted in regard to the best means of overcoming the various handicaps to production encountered by local home gardeners.

COOPERATION WITH MILITARY POSTS.

Under the broad policy of the commanding officers, the military posts have continued to contribute materially to the available food supply of the islands through their system of company gardens. At a number of the posts as much as an acre has been assigned to a company and special details made for each company garden. These details ordinarily consist of individuals who having had special experience in market gardening, are naturally enthusiastic in the work, and they have cooperated intelligently with the station in many ways. It is a pleasure to record that at the recent Territorial fair one of the companies won the blue ribbon for the best exhibit of white potatoes.

COOPERATION WITH PRIVATE GROWERS.

Considerable attention has been given during the year to the development and furthering of cooperative relations between the station and numerous private growers and concerns throughout the Territory. In these cooperative arrangements the station provides the plan for some experiment or demonstration which promises to give valuable information to the section in question. The necessary seed is also usually furnished by the station, while the cooperating individual furnishes the land and labor. The chief beneficial result of this work is that the cooperating grower provides himself with a first-hand demonstration of the relative merits of several of the most promising agricultural practices in connection with the crop or crops in question under his immediate local conditions. There is, therefore, no question as to the application of the findings of such cooperative experimental work. In addition to this, the station benefits in that it obtains valuable additional data concerning the responses of the various crops to the individual treatment given. A further educational benefit is derived, not only by the cooperative growers but also by the neighboring farmers, from the first-hand demonstration furnished by such work as to the desirability of each grower being his own experimenter, at least on a small or simple scale. The growers soon come to realize the advisability of always leaving a check plat to serve as a basis of comparison when trying out any special treatment on field scale.

THE TERRITORIAL FAIR.

The Territorial fair, held primarily for the purpose of stimulating food production and food conservation, was one of the most successful enterprises ever launched in the islands. The result of the food production propaganda of the past few years was demonstrated by the wide range of food crops placed on exhibit by growers representing nearly a dozen different nationalities. The cooperation of the military authorities in the way of equipment, organization, and program events contributed very materially to the success of the undertaking. All the agricultural institutions of the islands presented practical exhibits of their work, demonstrating either increased production or conservation of local foods.

One feature of no little interest was the daily exhibition of foods of the various nationalities, especially of the Japanese, Chinese, and Hawaiians, who demonstrated such of their foods as they considered best adapted for use as substitutes for wheat and other imported articles of diet.

Other very gratifying exhibits were those entered by a number of sugar plantations, showing the progress made in putting these plantations on a self-supporting basis as regards food for their laborers and feed for their work animals. One of the largest plantations presented evidence showing that it has been able to produce practically all the concentrate and roughage feed required by the thousand or more work animals in use on its properties. Another plantation company showed an interesting exhibit demonstrating the possibility of producing a form of alcohol from waste cane molasses for use as a substitute for gasoline. The same company has also developed a corn-meal grinding plant, a small model of which was in operation at the fair.

The general nature of the station's exhibits is indicated in Plates I, II, VI, and VII.

HORTICULTURAL INVESTIGATIONS.

The work of the horticultural division during the past year was principally concerned with the production of fruits and vegetables and especially the increased utilization of the banana, papaya, and tomato as food crops, particularly promising varieties of these being distributed as rapidly as propagating material could be made available. The division continued to give every possible support to the school and home garden propaganda work which has been very actively under way throughout the year.

One of the most promising phases of the work was a comprehensive test of numerous varieties of beans to determine the varieties best adapted for use not only as fresh string beans but also as commercial canning material for the pineapple companies, which necessarily are not in active operation during the considerable portion of the year when pineapples are out of season. It has been felt that the production of beans for canning on a large scale would serve to keep the canning plants in operation and also provide work for the labor force of the pineapple companies throughout the year.

An interesting experiment was continued looking to the development of a tomato resistant to the melon fly. Various hybrids have been made between the tomato of normal size, which is much subject to the attacks of the melon fly, and several strains of small tomatoes, including the wild tomato, which are resistant to the ravages of this fly. Several of the resulting hybrids have proved of good quality and sufficiently resistant to the fly to make a very welcome addition to the food supply of the islands.

CHEMICAL INVESTIGATIONS.

The drying of Hawaiian fruits and vegetables was considered of such practical importance as to receive most of the attention of the chemical division during the past year. It is not ordinarily practicable to produce a perfectly regular supply of some perishable food crops throughout the year. The customary gluts in the market at periods of overproduction have always served as a great deterrent to many growers who would otherwise produce food crops on a much more extensive scale. The consuming public in the islands, as regards any particular food crop, is somewhat limited, and a very ordinary overproduction will rapidly glut the market. It has been felt that if the overproduction at any season could be taken care of by means of commercial driers, the market would be stabilized and the growing of such produce would be put on a much more substantial foundation. It is also felt that there may be a considerable future in the production of vegetables for drying for export on a commercial scale. The economy in shipping space, packing materials, etc., favors the drying of vegetables which are to be consumed at any great distance from the point of production. This project has been furthered through the effective cooperation of Frank C. Atherton, of Honolulu.

During the year a summary of all available analyses of Hawaiian feeding stuffs was brought together and published in convenient form for ready reference.[1]

During November and December, 1917, the chemist made an inspection trip through Florida, Cuba, the Isle of Pines, and Porto Rico, where much information regarding the production of pineapples was obtained. This trip was made possible through the cooperation of the Hawaiian Pineapple Packers' Association.

The fertilizer experiments of the division have been continued, principally with rice, bananas, and pineapples. The field work has been chiefly in cooperation with private interests, while preliminary

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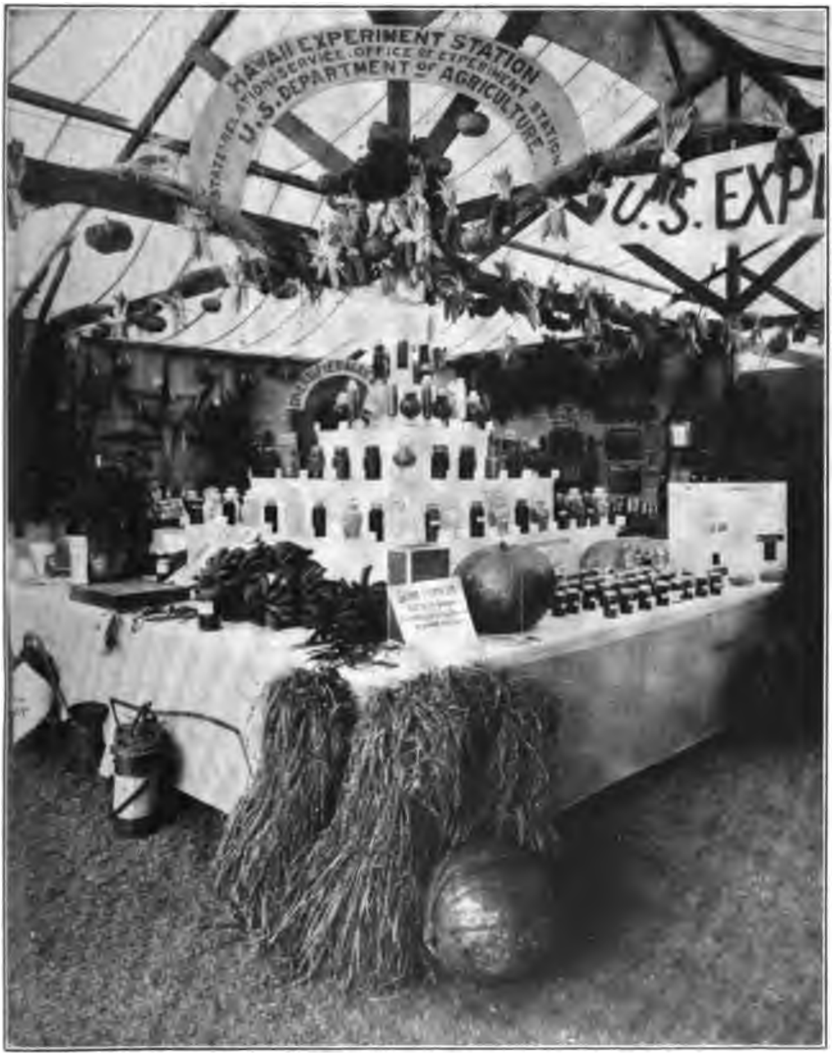
[1] Hawaii Sta. Press Bul. 53 (1918).


HAWAII EXPERIMENT STATION
STATES RELATIONS SERVICE, OFFICE OF EXPERIMENT STATIONS
U.S. DEPARTMENT OF AGRICULTURE
U.S. EXPI

GENERAL VIEW OF EXPERIMENT STATION EXHIBIT AT TERRITORIAL FAIR.

PLATE II.

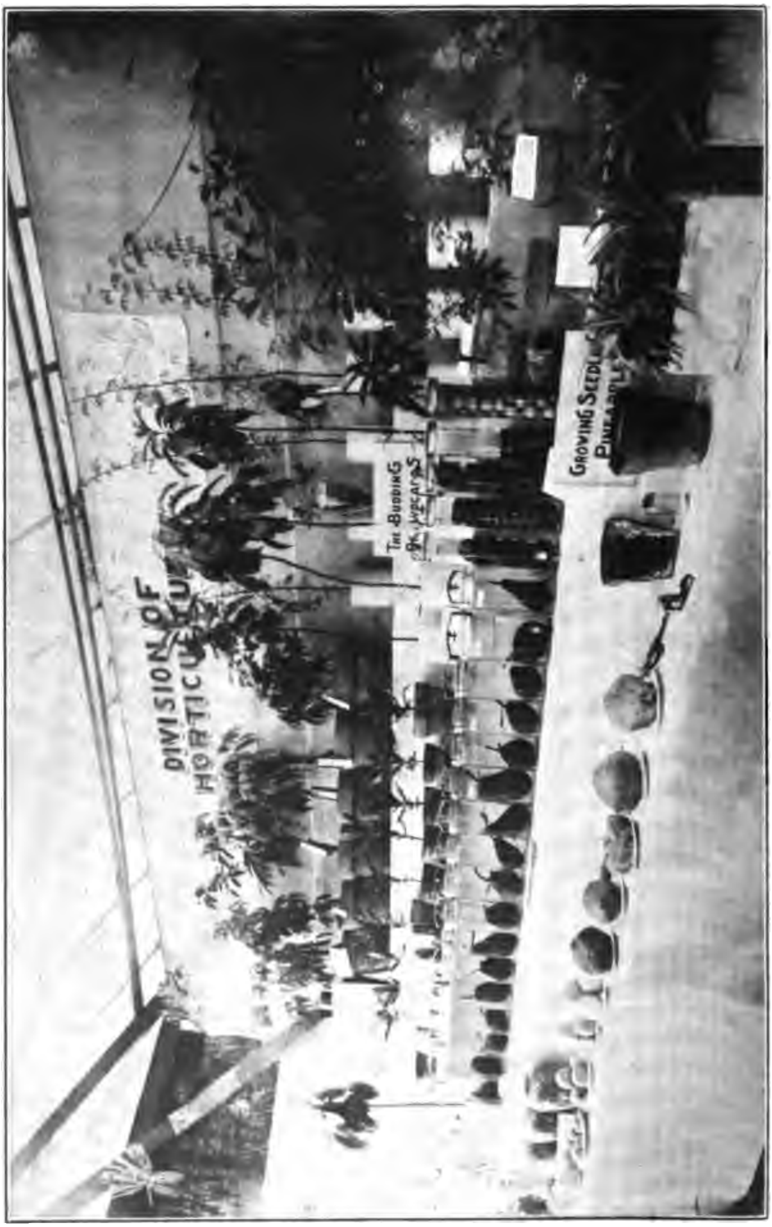


EXHIBIT OF HORTICULTURAL DIVISION AT TERRITORIAL FAIR.

experiments on a small scale have been conducted in pots at the central station. Considerable progress has been made in the determination of the nature of the effect of excess manganese on plant growth.

EXTENSION WORK.

The vital necessity of increased efforts looking to the local production of foods for man and feed for animals has resulted in a marked increase in the activities and responsibilities of the extension division. Cooperative demonstrations, which in former years were arranged for only with considerable difficulty, have been rapidly arranged for in numerous locations, and in many instances it has been impossible to undertake as many of these as desired by various private individuals and concerns which have been interested in the emergency food-crop production work.

A most important advance in the extension work of the islands was the appointment of a number of county agents by the Territorial Food Commission shortly after the outbreak of the war. These agents, provided with automobiles and other means of transportation, have been most effective in bringing home to the producing public the best agricultural practices worked out in the islands. It has been found that numerous isolated farmers have developed practical ideas which are with profit being adopted by the other farmers throughout the islands, the county agents serving as a means of communication between the isolated farmers and bringing about an exchange of valuable ideas. The extension division has cooperated closely with the county agents. The superintendent of extension has acted temporarily as county agent for Maui County and by reason of his wide experience in agricultural extension work has been able to give much helpful advice and information to the other county agents, especially during the first few months of their work.

The demonstrations at Haiku, besides serving the general purpose of demonstration farms, continued to be the source of a great deal of valuable agricultural information. The central station avails itself of the opportunity offered to conduct various experiments on a field scale, thus largely overcoming the disadvantages of conducting all the experiments on small plats. The dependence put in the results obtained at the demonstration farms at Haiku by the leading agricultural companies of the islands as well as by the packing and canning industries speaks well for the permanent and practical value of the work being accomplished.

Much of the success of the agricultural phases of the Territorial fair was due to the inspiring efforts of the superintendent of extension in stimulating interest throughout the islands and thus securing many exhibits which otherwise would not have been made such notable features. In addition, the superintendent also had immediate charge of the installation and general arrangement of the exhibits of the experiment station and of the decoration of the two large tents occupied by the agricultural exhibits. Practically every activity of the experiment station has been made the subject of further experimentation and demonstration on the Haiku farms, and in turn the best and most promising of the practices there worked out and developed have been passed on to the regular collaborators and private cooperators throughout the islands.

PLANT-DISEASE INVESTIGATIONS.

The rapid development of home and school gardens, together with the increased acreage planted to food crops on a large scale, has caused a material increase in the prevalence of various diseases and insect pests. The situation has been met as rapidly as possible through the determination of the most practical means of combating these various troubles. The use of the simplest spray pump and least complicated sprays has been emphasized, especially owing to the mixed population and the necessity of reducing such operations to their simplest possible form.

Probably the most serious disease which developed during the year is that of the banana, designated banana freckle or black spot disease. This has spread so rapidly from the valley in which it was first discovered that at the present time it seriously threatens the entire banana industry. The major portion of the pathologist's time during the coming year will probably be spent in an attempt to formulate a practical means of arresting the spread of this disease.

Another serious trouble was the taro rot, which caused material losses to many of the taro growers of the islands. Through the cooperation of one of the largest land-holding companies of the islands, experiments have been inaugurated looking to the development of practical means of controlling this disease.

The Irish potato continues to be affected by a number of troubles, including the late blight, early blight, mite disease, and tuber moth. Practical methods for control of these troubles have been worked out, and while much remains to be done, it is gratifying to be able to record that marked increases in yields have been repeatedly obtained by growers who have carried out the recommendations of the station.

Field and laboratory observations have revealed the presence of numerous miscellaneous fungus diseases and insect enemies of a great number of economic plants, especially food crops. An annotated list has been prepared and as rapidly as possible the most important troubles are receiving detailed attention.

AGRONOMIC INVESTIGATIONS.

In common with the efforts of the other divisions of the station, the agronomic work was directed chiefly along the lines of the production of forage and feed crops for animals and food crops for man.

The corn investigations have shown the variety introduced from Guam to be very resistant to the attacks of the corn leaf hopper and to give much higher yields than were obtained from any of the strains received from the mainland. The entire seed crop produced by the station is being used for the purpose of increasing the acreage of this strain of corn as rapidly as possible throughout the islands.

The work with the edible canna has been most promising, yields at the rate of over 40 tons of tubers per acre having been obtained 8½ months after planting. The station has made numerous distributions of tubers to individuals who have planted them as temporary ornamental plants in their yards, for the purpose, however, of utilizing them as an emergency food crop in case of necessity. The scarcity of tubers has prevented the planting of any considerable areas to this crop, it having been considered better to start numerous small patches from which additional plantings could be made in the immediate neighborhood of the initial plantings.

The Castner substation continued under the immediate oversight of the agronomy division, although the horticultural division has started some pineapple experiments and the chemical and pathological divisions cooperated in planning and carrying out experiments involving chemical and pathological features. The high percentage of manganese in the soil makes the problem of forage and food crop production very complicated, especially when combined with a low rainfall. Pigeon peas and sorghum appear to be very promising sources of forage. A heavy application of manure enables a number of food and forage plants to make a satisfactory growth in spite of the high manganese content of the soil.

GLENWOOD SUBSTATION.

The policy of the Glenwood substation, as compared with that of previous years, was changed somewhat during the past year. Upon the recommendation of the station, the Hilo Board of Trade appointed a Glenwood substation committee to keep in touch with the needs and activities of the substation and to serve as an intermediary between various interests, agricultural and otherwise, on the island of Hawaii and the Glenwood substation. The agricultural problems of the section in question are numerous and difficult, and the methods of approach are not always clear. The judgment of those having the policies of the substation practically in hand, combined with the counsel afforded by the board of trade committee, has done much to enable the station to carry on its work with a very satisfactory local support.

The increasing importance of food-crop production has led to the placing of additional emphasis on this line of investigations. Numerous varieties of the standard food crops have been placed under test to determine their adaptability to the peculiar local conditions. The poultry flocks continue to occupy a prominent place in the substation's activities, having proved a most valuable and profitable line of work. The trap-nest records of the selected portions of the flocks have been so satisfactory that the demand for hatching eggs has been greater than could ordinarily be supplied. The dairy, having proved unprofitable during a series of years, has been materially reduced in size. The Guernsey bull has continued to give satisfactory results throughout the neighborhood, and his services are being continued.

In addition to the experiments and demonstration work under way at the substation, the superintendent has spent two days of each week doing county-agent work for about 20 miles in each direction in the district surrounding the substation. He has also kept in touch with the work being done by the Territorial county agents in the other sections of the islands.

PUBLICATIONS.

Much of the information acquired by the station has demanded immediate presentation to the public. It is a pleasure to record the hearty cooperation in this work which has been accorded by the local papers throughout the islands in publishing the various articles submitted by the station's staff. Practically without exception the station has prepared each week one or more articles on timely agricultural topics which have been carried by one or more of the local papers. The quick response on the part of the public to such of the articles as suggested calling at the station for additional information or for seeds or cuttings of food plants has been ample demonstration of the promptness with which these messages reached the reading public.

The following publications have been issued by the station during the year:

Annual Report for 1917.
Bulletin 44, The Litchi in Hawaii.
Press Bulletin 53, Composition and Digestibility of Feeding Stuffs Grown in Hawaii.
Extension Bulletin 3, Emergency Series I, Field Production of Beans.
Extension Bulletin 4, Emergency Series II, Methods of Combating Garden Pests.

Extension Bulletin 5, Emergency Series III, Peanuts—How to Grow and Use Them.
Extension Bulletin 6, Emergency Series IV, The Banana as an Emergency Food Crop.
Extension Bulletin 7, Emergency Series V, Drying as a Method of Food Preservation in Hawaii.
Extension Bulletin 8, Emergency Series VI, Bean Spot Disease.

REPORT OF THE HORTICULTURAL DIVISION.

By J. Edgar Higgins.

The unusual conditions brought about by the war, demanding that every energy, not only of the Government but of the individual, be focused upon the one supreme object, have made it necessary to suspend in part the usual investigations looking to the betterment of horticultural practice and the improvement of plants in order to assist in the more immediate application of the best-known agricultural practices to crop production. A maximum production of food is the present necessity, and while the regular horticultural projects have not been lost sight of, much more attention than usual has been given to what may be termed extension activities. The greatly augmented local correspondence and the increasing volume of personal inquiry at the station bear testimony to the enlarged interest in the production of fruits and vegetables.

BANANA PROPAGANDA.

An extension bulletin[1] by the horticulturist on the banana as an emergency food crop had its origin chiefly in this problem of emergency food supply and also in part in the general need for a brief statement of cultural methods, there having been many requests for such information which it has been impossible to supply since the banana bulletin[2] of the regular series has been out of print. One object of the work was to point out some of the possibilities of the banana as the basis of a large and profitable industry which, in the event of the withdrawal of other products, could supply a substitute for the greater part of the farinaceous or starchy foods for the whole of the island population. It is a well-known fact that in many tropical countries the banana is one of the principal food crops of the population, but in Hawaii it is used chiefly as fresh fruit, little attention being given to the many ways of preparing it for the table, while banana flour and banana "figs," or dried fruit, the two most concentrated forms, are practically unknown. The bulletin discusses the production of the banana, its food value per acre yield as compared with other staple crops, some of the various forms in which the fruit may be concentrated, such as banana flour and banana figs, and also the present production and possible increase in plantings in Hawaii.

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[1] Hawaii Sta. Ext. Bul. 6, Emergency Ser. IV (1917).
[2] Hawaii Sta. Bul. 7 (1904).

The banana situation became somewhat complicated during the year when the ships used in carrying the fruit to San Francisco were one after another commandeered for war purposes, thus rendering it impossible to get more than a small portion of the fruit to market. No appliances were at hand to dry bananas or otherwise put them in nonperishable form. The station, through Mrs. J. M. Westgate, had worked out methods some months previous by which baked banana pulp could be mixed with wheat-flour dough, replacing one-third of the weight of the flour. The bread thus made was of excellent flavor, texture, and appearance. Various modifications of this method were devised by individuals and by the large bakeries for the use of bananas in bread, and this was found to constitute an outlet for considerable quantities of the fruit. A campaign for the increased consumption of bananas was instituted by Honolulu business organizations and supported by the local press. These combined efforts were to some degree successful in relieving the congestion of this fruit upon the market and in saving wheat and other imported foodstuffs. The prices received for bananas for such uses, however, were decidedly less than the net receipts per pound on fruit that had been shipped to the mainland. This fact, combined with the prospect of inadequate shipping space for some time to come, has resulted in diverting some of the banana lands to other crops. The present abnormally high price of sugar and the urgent need of all that can be produced tends to cause all suitable lands to be planted to sugar cane.

SCHOOL AND HOME GARDENS.

The horticulturist, as in the year previous, acted as one of the judges of school and home gardens in connection with the prize contests conducted by the Honolulu Star-Bulletin, visiting a large number of the home gardens and all of the school gardens on the island of Oahu several times. The home gardens were so numerous and so widely scattered that it was necessary for the judges to apportion among themselves the work of examination. The best of those reported by the different groups were then seen and compared by the entire board of judges for the awarding of prizes. The importance of this work can not easily be overestimated, for it has resulted in very keen competition and interest in the cultivation of the soil not only at the schools but at the homes. Better still, this interest has been reflected in the general community.

Concerning this work, the Hon. Franklin K. Lane, Secretary of the Department of the Interior, on his visit to Hawaii, spoke in part as follows:

> I have been deeply gratified at the spirit and ability which the Territory's children have put into their gardens and impressed with their realization of the significance of what they are doing.
>
> Through the stimulus given by this early movement, hundreds upon hundreds of gardens have been cultivated in every section of every island, and it is deeply impressive that this year more than 5,000 children were engaged in the Star-Bulletin contest, and, in addition, carried on active work for the Red Cross, for war saving stamps, and Liberty bonds.

TERRITORIAL FAIR.

Another extension activity has been in connection with the First Territorial Fair of Hawaii, held at Honolulu from June 10 to 16, inclusive. In connection with committees on field crops, fruits, and vegetables, and the committee on plants and cut flowers, preparations were made several months in advance to bring together the varied island products in a successful exhibition of large educational value which would serve particularly as an inspiration to greater production. The results, so far as they can be judged at this time, were highly satisfactory, a large and varied collection of products having been presented. Some points were also noted where greater emphasis should be placed at another fair.

Among the horticultural features meriting special mention was a collection of new seedling taros produced by G. P. Wilder, of Honolulu. In view of the importance of the taro plant to the whole archipelago and the failure of the crop in many places, a record should be made here of this, the first attempt, so far as known, to produce seedling varieties resistant to the prevalent diseases or otherwise superior to those that have been long in cultivation. The horticultural division of the station was able to extend to Mr. Wilder its propagating facilities for starting these seedlings, and it desires in every way possible to assist such important work.

A significant feature in the vegetable exhibit was the large number of cucurbitaceous fruits, including squashes and pumpkins grown at comparatively low altitudes. For many years these, with the exception of a few varieties, have been almost impossible of successful production because of the prevalence of the melon fly (*Dacus cucurbitæ*). The large number of specimens shown would seem to indicate that the melon fly's natural enemies introduced by the Territorial Board of Agriculture and Forestry have had an appreciable effect in checking the pest.

In the room occupied by the Hawaii Experiment Station, the division of horticulture presented a number of new plants, including rare varieties of litchi, new selections of algaroba, mate or Paraguay tea (*Ilex paraguayensis*), also roselle, Macadamia nuts and seedling trees, etc. A demonstration of the method of growing pineapple seedlings was made, showing the germination of the seeds and the care of the young plants up to the time when they are ready to be set out in the field. The budding of the avocado was illustrated by a number of trees, showing the different stages from the making of the incision in the stock to the completed process with the stock healed over where it had been cut off above the bud. A collection of tropical fruits in preservative fluid in museum jars was shown, including about a dozen varieties of avocado representing some of the best kinds discovered among the thousands of seedlings growing chiefly on the island of Oahu. Some citrus fruits grown at the station were shown fresh, also fruits of the snake gourd (*Trychosanthes anguina*) and of some of the papayas bred at the station were placed on exhibition and cut from time to time to demonstrate their qualities to especially interested observers (Pl. II).

DISTRIBUTION OF PLANTS.

It is the purpose to confine this work chiefly to dissemination of varieties bred at the station or to new introductions for further trial, as it is not considered the function of the station to send out seeds and plants of varieties easily secured from dealers. Wednesday afternoons and Saturday mornings were designated as distributing hours. There has been a larger demand than in any previous year for seeds and plants of the kinds of papaya and tomato in process of breeding at the station, and many thousands of these have been placed, usually in small allotments. Some varieties of sweet potatoes that had been under observation were placed with the division of agronomy to be disseminated with other varieties which that division had been growing. Several varieties of roselle also have been sent out. In the distributions, emphasis has been placed this year upon such plants as yield a rapid return in food products.

BEAN TESTS.

It is difficult to overestimate the value of beans as a food crop. The high protein content of the dried seeds is well known, and fresh and canned string beans, and also canned lima beans, are becoming more popular every year. Hawaii has produced only a small part of the dried beans that it consumes, and until the season of 1917–18 had never canned beans in any form on a commercial scale. This Territory may well profit by the experience of Porto Rico, that island having changed since the beginning of the war from a large importer to an exporter of beans. There are every year hundreds of acres of land in process of preparation for pineapple planting that would be benefited by the growing of a crop of beans and the plowing under of the vines. After the pineapple plants have been set out, there are several months during which they occupy only a small portion of the land upon which they stand, and it is probable that one crop of a compact, nontrailing variety of beans could be grown between the rows without any injury and possibly with benefit to the pineapples.

The high price of canned string beans in the American markets in the autumn of 1917 attracted the attention of Hawaiian canners. It appeared that Hawaii might produce a crop during the winter season and find a comparatively bare market, and to this end a small acreage was planted and the crop canned. Very few data, however, were available as to the varieties best adapted to Hawaiian conditions, although the experiment station had in part foreseen the need of information and had begun some variety tests. J. H. Cowan, of the horticultural division, began a series of such tests on October 1, 1917, by planting at the station the following varieties: Giant Stringless Green Pod, Stringless Green Pod, Black Valentine, Early Refugee, French Mohawk, Canadian Wonder, Six Weeks, Refugee Wax, Prolific Black Wax, Golden Wax, Ventura Wonder Wax, and Davis Kidney Wax. The first picking was made from these on November 19, the second on November 28, and the third and last on December 6. The data are given below:

Results of variety tests with beans.

Variety.	First picking.			Second picking.			Third picking.	Total weight of crop.	Percentage of total crop[1] stung by melon fly.	Estimated yield per acre.	
	Weight of crop.	Number of pods.	Percentage of pods stung by melon fly.	Weight of crop.	Number of pods.	Percentage of pods stung by melon fly.	Weight of crop.			Total weight.	Weight of sound pods.
	Lbs., oz.			*Lbs., oz.*			*Lbs., oz.*	*Lbs., oz.*		*Lbs.*	*Lbs.*
Giant Stringless Green Pod	12½	69	35.2	2 12¼	224	1.8	1 2	4 10¾	7.5	6,783	6,275
Stringless Green Pod	3 6¼	297	47.02	2 14½	203	5.72	5	6 9¾	21.2	9,534	7,513
Black Valentine	2 ½	219	47.9	2 8½	229	.43	5	4 14	16	7,078	5,946
Early Refugee	2 13½	405	......	4 10½	568	......	1 7½	8 15½	......	12,999	12,909
Stringless Refugee	2 0	238	2.1	4 8½	415	......	1 8¾	8 1¼	.76	11,729	11,640
Canadian Wonder	5 1	440	11.11	4 10	417	1.7	11	10 6	5.9	15,064	14,176
Six Weeks	1 13½	174	4.8	2 5½	202	......	12½	4 15½	2.1	7,191	7,040
Refugee Wax	1¾	14	......	12	80	......	12	1 9¾	......	2,336	2,836
Prolific Black Wax	2 3¾	234	3.08	3 2	232	.43	1 ½	6 6¼	1.7	9,279	9,122
Golden Wax	2 ½	213	18.3	2 3	220	.91	1 2½	5 6	8	7,804	7,180
Ventura Wonder Wax	2 2¾	223	1.36	2 5½	202	......	15¾	5 8	.7	7,986	7,930
Davis Kidney Wax	2 0	193	8.04	2 14	222	......	11½	5 9½	3.6	8,122	7,830
French Mohawk	3 14¾	328	15.9	1 12	257	1.2	9¼	6 4	9.6	9,097	8,224

[1] On basis of first and second pickings only, no records being available for the last picking, probably because of very slight injury.

It was found that an important factor in successful bean production lies in the susceptibility of the different varieties to the attacks of the melon fly. A careful count was made of the number of sound pods and of those stung in each of the first two pickings. In the last picking no such segregation is recorded, presumably because of the comparatively light infestation. It will be observed that Early Refugee and Refugee Wax received no injury whatever from the fly, the Stringless Refugee (not wax) and the Ventura Wonder Wax have each less than 1 per cent injury, 21 per cent of the Stringless Green Pod was stung, and varying degrees of susceptibility were shown by the other varieties. A noteworthy fact for which no explanation can be offered is that there was uniformly a very much higher percentage of infestation in the first picking than in the second.

The yields recorded in the column "Total weight of crop" are for an area of 30 square feet only, the tests having been begun on a small scale. Acre yields are calculations on this basis. They are valuable not so much in showing what yields may be expected from an acre as in showing the relative yielding power of the different varieties. In the last column, deductions have been made for the injured pods so as to show the relative yielding power of the varieties in terms of sound pods. Among the wax beans, the yield of sound pods is rather uniform in the varieties tested, except in the case of Refugee Wax, where it falls to less than one-third of that of the other varieties, notwithstanding the fact that its competitors suffered more or less severely from melon fly attacks.

The first eight varieties listed in the table are green podded. The Canadian Wonder is the heaviest yielder, but in respect to stringlessness and other qualities requisite in a first-grade bean for canning or for table use, it was not equal to some of the others. After careful tests of cooking qualities, flavor, texture, and absence of strings, it was concluded that the Stringless Green Pod, the Early Refugee, and the Stringless Refugee were of most promise as green beans for canning purposes or for table use under the conditions existing at the station.

Similar variety tests, including also some varieties of Lima beans, were undertaken on a somewhat larger scale in the pineapple lands of Aiea and Halemanu, both on the island of Oahu. Various combinations of fertilizers were applied in plats running at right angles to the rows. It is regrettable that, owing to the distance from the station and the impossibility of giving them continued close attention, these plantings suffered so severely from sudden insect attacks that no accurate data can be given as to the yields. In both cases the insects were cutworms and Japanese beetles which could probably have been completely controlled had the need been known in time.

The Stringless Green Pod appeared to be one of the best at Aiea. The fertilizer plats indicated the need of both phosphoric acid and nitrogen, the best appearing plats both at Aiea and at Halemanu being those to which was applied 1,500 pounds of acid phosphate and 500 pounds of sulphate of ammonia per acre.

TOMATO BREEDING.

The melon fly is the greatest enemy of tomato growing in Hawaii, the tomatoes in the local markets usually having been picked green and allowed to color in the house or store, where flies can not get at them. Such fruits do not attain the natural color and are quite lacking in flavor. As in the case of beans, there are wide differences in susceptibility to fly attack among tomatoes, but all of the large red-fruited varieties introduced and tested here have been found to be quite subject to attack. A small wild-growing sort, doubtless an escape from cultivation, appears to be immune, and a very large degree of resistance or immunity is possessed by the "pear" and "plum" varieties tried. But as all of these are small-fruited sorts, it seems desirable to combine, if possible, the fly-resistant character with the greater size of some of the standard kinds usually grown on the mainland. Mr. Cowan undertook the work of making certain crosses with this aim in view and also to determine, if possible, what constitutes the resistant character. It is regrettable that his work was terminated by Mr. Cowan's entry into military service before completion, but some valuable results were attained which are recorded here.

Flowers of the Earliana were crossed with pollen from the small wild form (Pl. III, fig. 1). The Earliana is a symmetrical, smooth variety, of small to medium size, bearing many of its fruits in clusters, while the small wild form is very symmetrical and round and also bears its fruits in clusters, but it is only about five-eighths inch in diameter. The first generation was variable and intermediate in size between the two parents, but all the fruits appeared to be free from infestation, except where otherwise injured (Pl. III, fig. 1). Several plants were selected, and seeds were taken from these for planting. The second generation also is recorded as having been free from attack at the station, and many thousands of seeds and seedlings of this generation were distributed for further trial. It was not possible to get any accurate record of the behavior in the majority of cases, but many favorable reports have been received, and there has been a strong demand for more plants.

Another cross was the Red Pear×John Baer. The fruits of the former are very small, distinctly pear shaped, and apparently immune to the melon fly, unless the skin is injured by birds, fungus diseases, or other causes. The John Baer is of medium size but is attacked by the pest. The first generation of the hybrid is recorded as practically free from attack, but the second has shown some degree of infestation.

It seems improbable that resistance is due to any single character. By a study of the habits of the fly in confinement with immune fruits it is seen that the female fails to sting the fruit and deposit her eggs because the ovipositor slips on the surface of the skin and can not penetrate. This would appear to be due to a combination of slipperiness and toughness of the skin. With varieties of less resistant fruit, the fly in confinement in the laboratory will make repeated futile attempts to oviposit on various parts of the skin until finally it finds the vulnerable spot, frequently at the point where the stem is attached to the fruit and is covered by the calyx. If there is sufficient flattened area about this point to afford a good foothold, and if at the same time the circle protected by a tightly fitting calyx is not greater in diameter than the length of the ovipositor, eggs are deposited here just at the base of the fruit. A tomato with a slight depression about the stem end is subject to attack at this point, while one such as the Red Pear is difficult or impossible of attack. Again, if a tomato is of very uneven surface or "ribbed" (marked with depressed lines, as is the case with the Ponderosa type), it becomes extremely vulnerable at many points. Very few, if any, of these will escape destruction by the larva of the fly, while those forms that have but one vulnerable point will escape in larger numbers. There may be other elements entering into the problem, but from observations it would appear that any tomato to be bred for resistance to the fly must combine many characters, first, those relating to shape, of which there may be several, and, second, those relating to quality of skin, which must combine toughness with a degree of smoothness amounting almost to slipperiness.

PINEAPPLES.

The pineapple seedlings planted at Kunia, Oahu, in the autumn of 1916 began flowering in the spring of 1918. Several hundred seedlings were planted out in the autumn of 1917 at Waikakalaua in a well-prepared field which was being planted for the second time to the usual variety (Smooth Cayenne). These were thus placed under ordinary field conditions. The soil is rather highly manganiferous, but the fields are regularly sprayed with iron sulphate, which has been universally adopted in Hawaii to overcome the troubles due to manganese. This should give the seedlings a fair chance to demonstrate their suitability to such field conditions. The seedlings and the surrounding plants made practically no growth during the entire cool season, but on the return of warm weather they began, about the latter part of May, to take on green color and to increase in size. This and similar experiences elsewhere point toward the desirability of planting out pineapple seedlings in the spring rather than in the late summer or autumn.

The seedlings at the station propagating yards and houses have been found to be very sensitive to the effects of temperature. In a glass house where they have protection from cold during the winter they will continue to grow and maintain a dark-green color, while plants of the same lot in soil similarly prepared and in the same sort of containers will lose their chlorophyll, take on a pink color, cease growth, and become weak in appearance when placed outside. These results are secured during the winter whether the plants are exposed to sunlight or partly shaded, though they begin to revive with the return of warm weather. Plate III, figure 2, shows two boxes of pineapple seedlings. The larger plants are a fair average of those being grown under glass, while the smaller constitute an equally fair sample of those growing on tables in the propagating yards, but the smaller plants in this case are 13 months older than the others. A thermograph record on the tables in the propagating yards during the cool season tends to run under the line of 70° F. for the greater part of the time, with a frequent rise for several hours of the day to between 70° and 75°, not infrequent falls during the night to between 60° and 65°, and an occasional record as low as 58°. In the glass house the temperature runs about 10° higher than outside, and the hours of lowest temperature of each night and early morning are shortened because the house retains heat. When seedling pineapples have become established in the fields, it has not been observed that they show greater sensitiveness to cold than do the Cayenne plants, but during the first year or more of their development they require considerable heat.

The work of growing more seedlings was continued so far as seeds have been available. Many hundreds of plants are now awaiting transplanting, including some hybrids of Queen×Cayenne, and several hundred more are ready for the first transplanting in the glass house.

REPORT OF THE CHEMICAL DIVISION.

By Maxwell O. Johnson.

Due to the national and local food shortage, much of the more technical research work of the chemical division was suspended during the past year, and attention was devoted to the determination of practical methods for the preservation and utilization of locally grown food crops. Experiments were made in drying Hawaiian food products and also in canning and preserving food crops. A number of feeding stuffs were analyzed, and a summary of all analyses performed by the station was published. Some fertilizer experiments were made with pineapples and bananas. On a trip to the pineapple fields of the West Indies and Florida information was gathered of considerable value to the Hawaiian industry. The investigations concerning the biochemical influence of manganese were continued.

DRYING HAWAIIAN FRUITS AND VEGETABLES.

As drying is the simplest and cheapest method of food preservation, an extensive investigation is being made of the drying of Hawaiian food products. The banana, taro, cassava, sweet potato, edible canna, and Irish potato have been the chief subjects of experiment, as these crops are grown in Hawaii in sufficiently large quantities to make their production at times likely to exceed the immediate demand. An air drier constructed by the station with a capacity of about 150 to 200 pounds of wet material has given good results both in experimental and practical use in drying under Hawaiian conditions (Pl. IV). Experiments in drying the above-mentioned food products with this drier were published during the year.[1] Drying appears a particularly valuable method as applied to cassava, since it eliminates the two most serious objections to this important heavy-yielding food crop, namely, the content of hydrocyanic acid[2] of the fresh roots and their liability to rapid decay due to the moisture contained. Flour made from the peeled, dried cassava root appeared to be very promising as a wheat-flour substitute, as a very fine white flour was secured at low cost of production. A hot-air oven was used to dry the ripe banana, mango, and papaya, these giving dried products of good quality which appear to offer commercial possibilities for Hawaii.

A tower hot-air drier is in process of construction which will have a capacity of about 300 to 400 pounds of wet material. In this drier the air is heated by steam coils and blown over and through the trays loaded with the products to be dried. This drier is a unit which can be multiplied to give any desired capacity in commercial use. A small vacuum drier has been ordered, and this method of drying will also be investigated.

ANALYSES OF FEEDING STUFFS.

Due to the shortage and high prices of feeding stuffs, considerable interest has been manifested in home-grown feeds. In order to assist in developing local sources of supply, a summary of analyses of

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[1] Hawaii Sta. Ext. Bul. 7, Emergency Ser. V (1918).
[2] Hawaii Sta. Rpt. 1916, p. 24.

Hawaiian feeding stuffs was published during the past year.[1] In this bulletin all the analyses of Hawaiian feeding stuffs made by the chemical division of the station were collected and arranged in a table convenient for comparison with standard tables of American feeding stuffs. On the assumption that the digestibility of Hawaiian-grown feeding stuffs is about the same as that of similar American feeding stuffs, a second table was prepared showing the approximate digestible nutrients and also the nutritive ratios for the different Hawaiian feeding stuffs.

TRIP TO THE WEST INDIAN PINEAPPLE FIELDS.

During the months of November and December, 1917, the chemist made a trip to the pineapple fields of Florida, Cuba, the Isle of Pines, and Porto Rico. The leading pineapple growers of the different districts were interviewed and an inspection made of their fields. Much information of interest to the Hawaiian pineapple growers was secured as to varieties, methods of planting, cultivation, fertilization, etc. The material is being prepared for publication as a bulletin of this station. The Abakka pineapple appearing desirable for introduction into Hawaii, steps are being taken for a trial of this variety on Hawaiian soils.

LIMING HAWAIIAN SOILS.

Most of the work on the effect of liming Hawaiian soils has been discontinued for a time. A preliminary report of an investigation of the reaction of Hawaiian soils with calcium bicarbonate solutions was published during the past year,[2] showing the relation of this reaction to the determination of the lime requirements of soils. A rapid approximate method of determining the lime requirements of soils given in this article appears to offer many advantages for routine soil examinations.

FERTILIZER EXPERIMENTS WITH RICE, BANANAS, AND PINEAPPLES.

Experiments have been made in applying dilute solutions of fertilizing salts to rice. Ammonium sulphate was the only treatment to give any notable increase in yield, a result confirming previous work[3] of the station as to the value of ammonium sulphate as a rice fertilizer. In similar spraying experiments with bananas, ammonium sulphate and potassium sulphate solutions stimulated growth. With pineapples, ammonium sulphate solution gave good results on manganese soils. Nitrate of lime produced very good results with pineapples on windward Oahu, but due to war conditions, this fertilizer has unfortunately not been on the market for some time. As only a small amount of fertilizer can be supplied in a single spraying, this method of application does not appear practical except in certain special cases, as on manganese soils where ammonium sulphate can be added to the iron sulphate solution which is already being extensively used for spraying.

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[1] Hawaii Sta. Press Bul. 53 (1918).

[2] Jour. Indus. and Eng. Chem., 10 (1918), No. 1, pp. 31-33.

[3] Hawaii Sta. Rpt. 1907, pp. 67-90; 1908, pp. 65-82; Bul. 24 (1911).

A small fertilizer experiment with pineapples was started in the fall of 1917, in the Waipio district of Oahu. Several insoluble fertilizers were applied singly and in mixtures directly in the heart of young plants. Up to the present time, dried blood at the rate of 250 pounds per acre has given quite striking results. In Porto Rico, "top feeding" the pineapple in this manner with cottonseed meal or dried blood is said to have fertilizing value and also to prevent "sanding." This method has been practiced in Hawaii only to a very small extent, but as a result of demonstration experiments at the station, it is now being quite extensively adopted by the Hawaiian growers.

MANGANESE INVESTIGATIONS.

The iron sulphate spraying treatment developed by this station[1] as a practical means for overcoming the very injurious effects of highly manganiferous soils on pineapples has met with continued success (Pl. V, figs. 1 and 2). Several thousand acres were added during the past year to the 5,000 which were noted last year as being under the spraying treatment.[2] In practice it has been observed that iron must be frequently supplied to the plant during the periods of rapid growth, but that comparatively few sprayings are necessary during quiescent periods.

Methods of treating the manganese soil before planting to supply iron to the plant have thus far given no success, with the exception of the use of stable manure, and in this method it appears that the pineapple is grown on the manure rather than on the soil. In a coöperative field experiment several promising methods of treating the manganese soil have been tried. As investigations have shown that sulphur is slowly oxidized in the soil, flowers of sulphur was applied to the manganese soil at rates of 500 to 3,000 pounds per acre in the hope that by the aid of the acid formed by this oxidation, possibly some of the immense quantity of iron locked up in the soil would be liberated. Additions were also made to the manganese soil, at rates of 1 to 6 tons per acre, of a red, very acid, upland soil containing apparently considerable quantities of available iron. A third

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[1] Hawaii Sta. Press Bul. 51 (1916).

[2] Hawaii Sta. Rpt. 1917, pp. 7, 26.

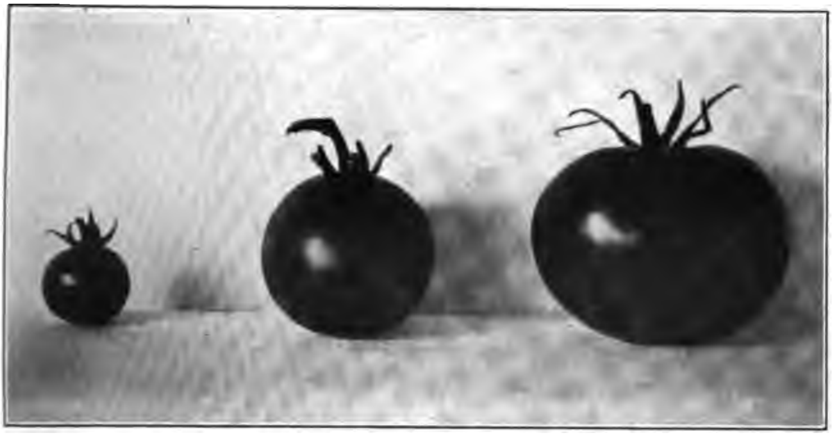


FIG. I.—HYBRIDIZING TOMATOES. WILD PARENT AT LEFT, EARLIANA PARENT AT RIGHT, HYBRID IN CENTER.

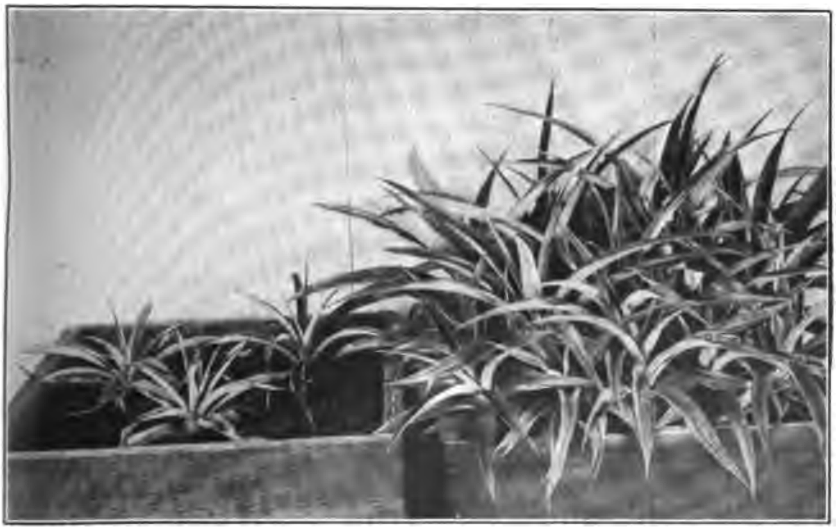
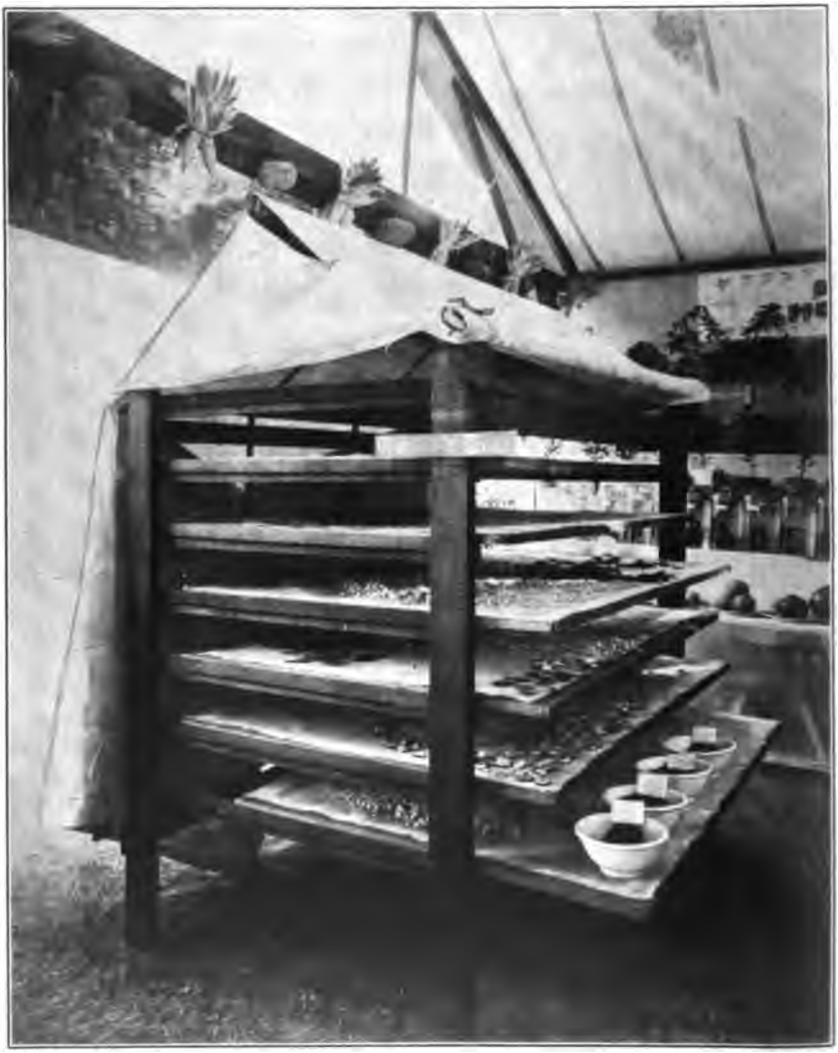


FIG. 2.—EFFECT OF HEAT ON PINEAPPLE SEEDLINGS.

Plants at right grown in glass house during cool season, those at left grown in the open.



AIR DRIER FOR VEGETABLES, SHOWING PROCESS OF DRYING AND DISHES PREPARED FROM DRIED PRODUCTS.

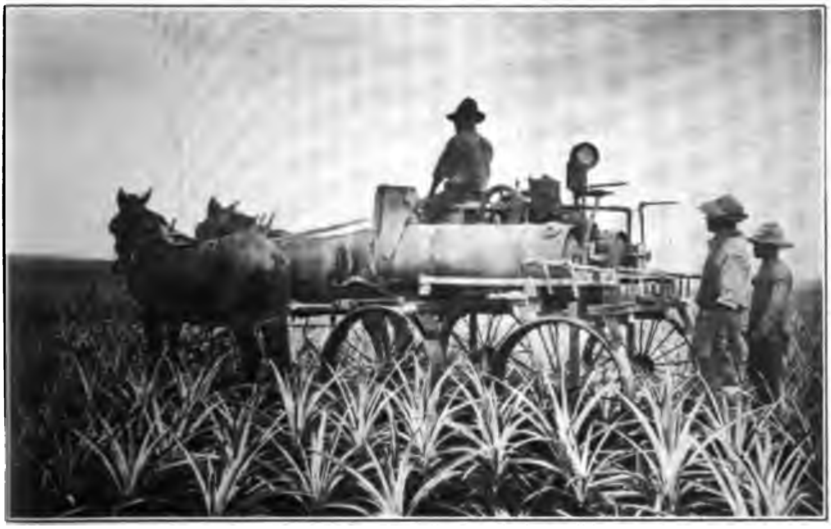


FIG. 1.—HIGH POWER SPRAYER USED FOR TREATING PINEAPPLES WITH IRON SULPHATE SOLUTION.

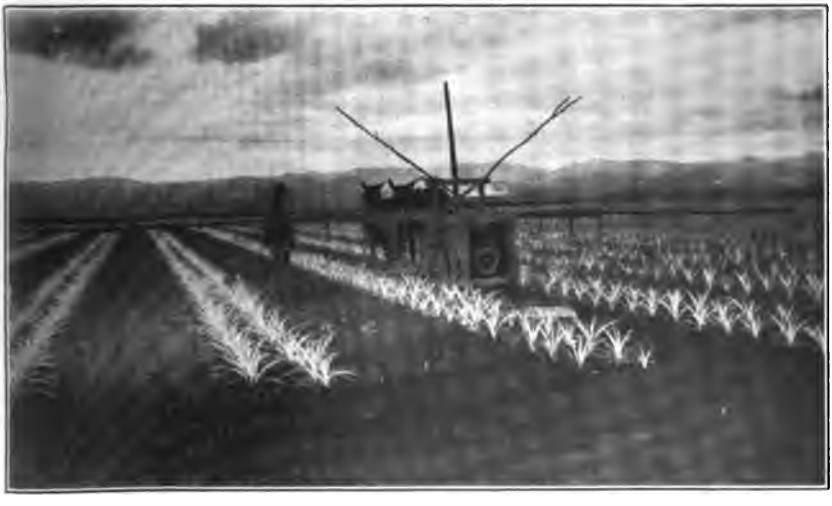


FIG. 2.—MACHINE DEVISED FOR SPRAYING 12 ROWS OF PINEAPPLES AT A TIME.

treatment tried was the application to the soil of bagasse soaked in very strong solutions of iron sulphate. The plants in these experiments, at present about 10 months old, have shown no striking differences as yet between the treated plats and the checks.

Series of experiments were made with rice grown in nutrient solutions to determine the effect of additions of manganese dioxid and of manganous sulphate. Preliminary experiments indicated that the effect of manganese depends largely on the amount of iron supplied by the solution. Accordingly, manganese dioxid was added to the nutrient solution at the rate of 0.4 gram per liter and manganous sulphate at the rate of 50 milligrams per liter, with ferrous sulphate supplied at rates of 5, 10, 20, 40, and 80 milligrams of iron per liter. With the smallest amount of iron supplied, which was, however, sufficient for the normal growth of the checks, manganese dioxid and manganous sulphate caused an extreme depression in growth, the plants in these solutions being light yellow in color with brownish spots. As the amounts of iron were increased up to the very excessive amounts supplied by the highest rate employed, the injurious effects of the manganese were overcome and growth approached that of the checks. Dipping the leaves of the plants at intervals in a dilute solution of ferrous sulphate was also partially effective in overcoming the injurious effects of manganese dioxid. This experiment, repeated with ferric chlorid and with ferric citrate as sources of iron, gave similar results.

Several investigators[1] have claimed stimulated growth as a result of adding manganese to nutrient solutions, but an examination of their work reveals, in most cases, that the effect on growth was determined only by rough measurements of the increase in the height of the plants and that the iron content of the nutrient solutions used was many times that necessary for normal growth and so excessive as to mask the injurious effects of manganese.

Further experiments planned in order thoroughly to check the results obtained have been temporarily held in abeyance by the emergency conditions at present prevailing.

PINEAPPLE WILT.

Serious trouble continues to be experienced with this disease in Hawaii. Burnt lime has been partially effective but can not be considered entirely successful in controlling wilt. In pot experiments a yellowish-brown soil was used on which in the field practically every plant had wilted. Under the well-drained conditions in pots no wilt occurred in any of the pots, even the untreated ones. The plants in the untreated pots showed a tendency to "grow out" of the soil and had only a few surface roots alive. Plantings made in a manganese soil under similar conditions had a very extensive root system. The best means for control of wilt at the present appear to be application of burnt lime before planting, planting in a single-row system on gentle ridges, keeping the soil well hilled up about the base of the plants, and applying air-slaked lime or a mixture of air-slaked lime and reverted phosphate in the heart of the plant.

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[1] Loew, O., and Sawa, S., On the action of manganese compounds on plants, Bul. Col. Agr. Tokyo Imp. Univ., 5 (1902–3), pp. 161–172; Pugliese, A., Sulla biochimica del manganese, Atti R. Ist. Incoragg. Napoli, 6. ser., 65 (1913), pp. 289–315.

REPORT OF THE EXTENSION DIVISION.

By F. G. Krauss.

The results of the work of the extension division during the past year were very satisfactory. It is gratifying to record increased interest in the work of this division on the part of practically every industry in the islands, the sugar and pineapple plantations, as well as the ranches, cooperating more closely than ever in the establishment of diversified agriculture in the Territory. The implement dealers and fertilizer manufacturers are also cooperating, while there was noted a marked tendency on the part of merchants to give increased preference to island-grown produce rather than to imported foods. During the year the superintendent of extension work has devoted about one-third of his time to extension and demonstration trips throughout the various islands, the balance of his time being spent in active charge of the Haiku substation (Pl. XI, fig. 1.)

COLLABORATORS AND COUNTY AGENTS.

Two additional homesteaders collaborated with the station during the year, John H. Midkiff at Kealakekua in the Kona homestead district on Hawaii and J. Anjo in the newly opened Haleakalea tract on Maui. The employment of collaborators in the various districts to serve as representatives of the division and to demonstrate on their own farms the most approved agricultural practices is proving a very satisfactory method of bringing the desired agricultural truths home to the farmer. There are now three collaborators on Hawaii and one on Maui, in addition to the substation and demonstration farms at Haiku in direct charge of the superintendent of extension. There is also one collaborator on the island of Kauai, while the island of Oahu is provided for by the central experiment station at Honolulu and the substation at Castner. Plans are under way for the establishment of a collaboratorship on the island of Molokai.

The work of the collaborators forms an important link in the agricultural-extension chain. Usually the collaborator has some demonstration work in progress on his farm, which is frequently the headquarters for supplying new and tested seeds and cuttings to the neighboring farmers. In this connection it may be mentioned that John de C. Jerves, the collaborator at Kalaheo, Kauai, has distributed more than a million cuttings of the now famous Madeira or Kauai sweet potato, which he was instrumental in bringing to the attention of the producing and consuming public.

The work of J. E. Gamalielson, collaborator at Kaumana, near Hilo, Hawaii, is especially noteworthy. He took over the management of the Glenwood Creamery Co., a cooperative organization of dairy farmers established through the efforts of the Glenwood substation, in August, 1913. A brief history of this cooperative effort, covering the five years of its existence, is given below, having been prepared by him:

> A summary of business transacted by the Glenwood Creamery Co. year by year is presented for the five years of its existence. A beginning having been made the first of June, 1913, May 31 in each succeeding year has herein been considered as the end of the year.
>
> In 1913, F. A. Clowes, then superintendent of the Glenwood substation, built and equipped a creamery at the substation for the purpose of assisting the farmers in the district to produce a good, marketable grade of butter and to find a market for it. After having operated the creamery for some months as part of the work of the substation, paying for the cream according to the butter fat contained in it and making and marketing the butter as the property of the substation, he made arrangements for and called a meeting of the farmers interested, which meeting was held on May 22, 1913.
>
> The farmers then agreed to take over the operation of the creamery and have it operated for them on a cooperative basis and the product marketed the same way, each one to pay into the treasury of the concern $10 for each cow from which to furnish cream, to be paid in 10 monthly installments. The total amount so subscribed was $1,050. Interest-bearing notes were given for the respective sums subscribed and the secretary was authorized to deduct the monthly installments from what became due each of the respective subscribers each month, until the full amounts subscribed had been collected. This was to furnish working capital, as some additional equipment and an addition to the creamery building were needed. Mr. Clowes consented to remain secretary and manager for the concern, which he did until the end of August, at which time J. E. Gamalielson, of Kaumana, was elected secretary, as he lived nearer the market and it was considered easier for him to attend to the marketing, billing, collecting, and remitting to each man his share of the proceeds. Mr. Clowes remained in charge of the creamery and superintended production.
>
> At the time the farmers took over the creamery, butter was selling at 45 cents per pound, wholesale, but about that time Australian butter was coming in and selling as low as 28 cents per pound, and the farmers were forced to discontinue operation of the creamery at the end of November, the same year. but each man made his own cream into butter which was marketed cooperatively.

Summary of business of the Glenwood Creamery Co. for the five years of its existence.

Year.[1]	Amount of butter marketed.	Average price per pound.	Total returns.	Cost of marketing.	Percentage of cost.
	Pounds.	*Cents.*			
1913-14	12,580	41.55	$5,234.56	$300.00	5.73
1914-15	12,683	35.78	4,534.38	291.19	6.5
1915-16	11,314	35	3,965.38	312.75	7.75
1916-17	5,174	38.35	2,036.46	122.92	6
1917-18	4,276	52.8	2,257.76	117.50	5.2
Total	46,027	39.16	18,028.54	1,144.36	6.35

[1] Each year ending May 31.

The falling off in production was caused by competition with imported butter, a number of farmers finding dairying unprofitable and giving it up. Later on the high cost of feed and labor forced them to do without grain feed, to milk only the best of the cows, and to let the others suckle the calves. Some of them had to leave the butter making to the women and children and go out to work for wages in order to meet the constantly increasing cost of supporting their families. At present, with better prices for the product, more butter is being made, but the demand for it being better more of it is being sold near where it is made and is not recorded here.

The cost of marketing covers salaries and telephone rent. Freight charges, which come to from one-half to two-thirds of a cent a pound, according to distance and amounts shipped, are not included.

In addition to his duties as secretary of the cooperative creamery, Mr. Gamalielson operates a successful dairy farm of his own. So far as is known, there is here installed the only set of mechanical milkers in the Territory. In addition to the dairy, a large flock of poultry is maintained, and skimmed milk is utilized to a large extent by the poultry. Both the dairy herd and the poultry flocks are fed largely from farm produce. The total area of Mr. Gamalielson's farm is 74 acres, of which 20 acres is classed as agricultural. This has recently been planted to sugar cane, and the remainder is rough pasture land of which a few acres has been planted to crops for the live stock and the household. Mr. Gamalielson's net average income during the past three years has been about $1,000 annually in addition to his living expenses.

John de C. Jerves, at Kalaheo, Kauai, is field foreman for the Kauai Fruit and Land Company and owns a five-acre homestead at Kalaheo. No one has better demonstrated the agricultural possibilities of a small tract of land well tilled than has Mr. Jerves. The most noteworthy individual activity on his part has been the introduction and distribution of the Madeira sweet potato throughout the islands. No variety is more widely planted now, nor has any other commanded a higher price on the Honolulu market. During a period of temporary overproduction of potatoes in certain seasons of the year, Mr. Jerves has experimented with the feeding of the sweet potato to work mules, cattle, and swine. He finds that the feeding value of this crop, based on present feed prices, is approximately $20 per ton. Since the yield from a 6 to 8 months' crop is about 8 tons per acre, it will be seen that the potato may be made profitable as stock feed alone. Mr. Jerves was visited by the superintendent of extension work during June, 1918, and was found to be encouraging the production of corn, beans, and other crops by both small and large growers throughout the island of Kauai.

In the Waimea homestead district Alexander Arthur was appointed collaborator in 1916. Being one of the earliest settlers, he has a well-established diversified farm of approximately 80 acres. Mr. Arthur has been a successful corn grower and swine raiser. Potatoes, dryland taro, and beans succeed well, and his farm is becoming more and more a valuable demonstration unit.

The newly established collaboratorship at Kealakekua, to which John H. Midkiff was appointed in 1918, is centered in the thriving agricultural district of North Kona. Here many of the small homesteads were first opened for settlement. One of the main objects in establishing a demonstration unit at this place was to test new and promising crops under the direct supervision of the extension division. Mr. Midkiff is a graduate of the animal husbandry course of the University of Illinois. His interest in animal husbandry is indicated by his maintenance of a public service boar for the benefit of the hog raisers of the community. He has also established a free market at Kealakekua where the small farmer brings his produce for sale every Saturday.

The collaboratorship established in the newly opened Haleakalea homestead district on Maui in February is an attempt to help the new settlers from the beginning. J. Anjo, who has been closely identified with the opening of these lands and who has the interest of the settlers at heart, was considered the most suitable person to undertake the work in hand. Through the commendable community spirit shown by the settlers, 40 acres of the demonstration unit was broken up and has had two harrowings and a second plowing. A third plowing and disking will be necessary for the initial plantings of pigeon peas and Japanese cane to demonstrate their value for feeding purposes and to serve as temporary windbreaks until trees can be established. The establishment of this demonstration unit by the Territory marks an important advance in the development of the various homestead districts throughout the islands in that it recognizes the necessity of preliminary experiments and demonstrations for the benefit of the new farmers who take up the homesteads, often without the necessary capital to justify them in making what may prove costly experiments in crop production. The different districts vary so greatly as regards soil and rainfall that what succeeds in one section is little or no indication as to what will succeed in a neighboring locality. This clearly indicates the necessity of preliminary work on the part of the extension and demonstration organizations of the islands.

Through the cooperation of the Haleakalea ranch, in the center of whose holdings is situated the Haleakalea homestead tract, the demonstration farm has been enabled to fence a part of its land. The most urgent need of this enterprise is financial assistance, either from the county or Territorial Government, for the completion of the fencing and the erection of a group of farm buildings consisting of a small residence, barn, and outhouses. The entire expense of the necessary equipment, which in itself would prove a valuable demonstration in efficient and economical building, should not exceed $2,500.

COOPERATION WITH TERRITORIAL COUNTY AGENTS.

The 1917 session of the Territorial legislature provided for the employment of a number of county agents throughout the islands. The closest sort of cooperative relationship has been in effect with these county agents. During the greater part of the calendar year 1917, the superintendent of extension work acted largely in the capacity of county agent for his particular district. He has also kept in close touch with the various county agents throughout the islands and has been of great assistance to them.

The following are abstracts from the report of the superintendent of extension work while acting as county agent for Maui for the period July 1, to December 31, 1917:

> Total farms visited 108. Some of these were visited bimonthly, over 500 distinct visits having been made by the county agent and his assistants during the period of six months covered by this report.
>
> More than 5,000 miles was traveled by automobile, and about 800 miles on horseback.
>
> More than 100 acres of potatoes was sprayed for blight and insect pests.
>
> Twelve thousand pounds select seed potatoes was distributed for the improvement of the potato crops in Kula and Makawao regions.
>
> Three thousand packets of seed were distributed, most of these being of new and improved varieties grown at the Haiku substation.
>
> More than 80,000 sweet potato, cane, and cassava cuttings were distributed from the Haiku substation.
>
> A large amount of agricultural and food commission literature was distributed. Weekly agricultural letters have been prepared for the press, about 30 such articles having been published during the half year. Several talks on agricultural subjcts were also given before good sized audiences.
>
> Plans for several agricultural projects have been prepared for private enterprises. In a number of cases the complete equipment will represent the outlay of thousands of dollars.

The bean-canning projects now under way are largely the outcome of the county agent's endeavors, and may result in the development of an important industry in the near future.

Numerous visitors have called at the substation and demonstration farms.

The correspondence and personal consultation with both large and small farmers have been extensive.

EXTENSION BULLETINS.

Supplementing the general agricultural propaganda of personal visits by the station and extension division staffs, extension bulletins were issued during the year[1] on the field production of beans, methods of combating garden pests, how to grow and use peanuts, bananas as an emergency food crop, and bean spot disease.

In addition to the above, numerous articles have been prepared for the local press in which practical subjects received immediate attention and reached a wide circle of readers. A number of talks on agricultural subjects were given in the rural communities by various members of the staff.

FIRST TERRITORIAL FAIR.

The various activities of the extension division were featured at the Territorial fair held June 10 to 16, 1918 (Pl. VI). The extension division exhibited its seed-selection work with potatoes, its home-grown concentrates for stock feeding, its seed-corn selection work, and the production of substitutes for wheat flour. In addition to this, a series of photographs showed the work in progress on the farms of the various collaborators throughout the islands.

EXTENSION OF NEW VARIETIES OF CROPS.

Special emphasis has been laid on the importance of obtaining the proper varieties of field, forage, and green-manuring crops. High yields of field corn were produced during the past season, notwithstanding the exceptional drought through which the crop was forced to pass. A considerable portion of the farm at Haiku produced shelled corn at the rate of 77 bushels per acre. The variety now exclusively grown on the demonstration farms is the New Era, a 100-day yellow dent corn developed by the extension division by hybridizing Gold Standard Leaming, Reid's Yellow Dent, and Funk's Ninety Day. This variety, which is each year growing in favor, during the past season was planted on 100 acres on the island of Maui. At the recent Territorial fair the first and second prizes for the best ear, and the first prize for the best 100 pounds of shelled corn were awarded to this variety. About 500 pounds of selected seed has been distributed during the past three years, and a considerable seed trade is being developed for this variety by the corn growers on Maui.

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[1] Hawaii Sta. Ext. Buls. 3, 4, 5, 6, and 8 (1918).

The Japanese cane introduced by the extension division some years ago is each season increasing in general favor, no forage crop having withstood the severe drought of the last season better than this cane. One-half million cuttings have been distributed during the year to interested dairymen.

Cowpeas and velvet beans continue to be important crops, and are more extensively planted each season.

Perhaps the most promising crop now under cultivation at the Patterson demonstration farm, Haiku, is the 15-acre field of pigeon peas (*Cajanus indicus*) of the variety New Era. This planting was made in March, 1917, as an intercrop between corn rows. While the drought almost ruined the corn crop the pigeon peas continued to thrive and yielded heavy crops of both seed and forage. A quantity of the seed has been sold in advance for $200 per ton, while the cured forage with pods attached is bringing $40 per ton in the field. Meal prepared from the whole plant has been fed extensively and with satisfactory results to work mules, milch cows, and swine. It seems very probable that hundreds of acres will be planted to this crop during the coming season. The pigeon pea is to the poor dry waste lands what alfalfa is to the rich moist bottom lands of Hawaii.

LIVE-STOCK FEEDING PROBLEMS.

In connection with the development of the extension division farms at Haiku, Maui, constant effort has been made to maintain a balance between crops, live stock, and labor, it being realized that it is essential at the present time to make greater and greater efforts to conserve food, fertility, and labor. As a result of this policy the live stock has been built up until now there are 6 work mules, 4 milch cows, 100 laying hens, and a herd of about 40 head of swine, which are maintained on the 100 acres comprising the two demonstration farms. No produce leaves these farms except the selected seed used for the purpose of extending the improved varieties. The cull seeds, straw, and forage are fed on the place. There is no waste. The manure from the cattle is conserved and has added not a little to the fertility of the land. Vegetable matter not utilized as feed is plowed under as green manure. The labor has been equalized by the development of diversified projects until the working force is now of uniform size throughout the year, thus resulting in greater efficiency and economy. As an outgrowth of the experiments in regard to growing, milling, and feeding of home-grown concentrates conducted at the Haiku substation during the past three years, there has been developed in the past year at the Haiku ranch of the Maui Agricultural Co. a plant for the preparation of 10 tons of mixed home-

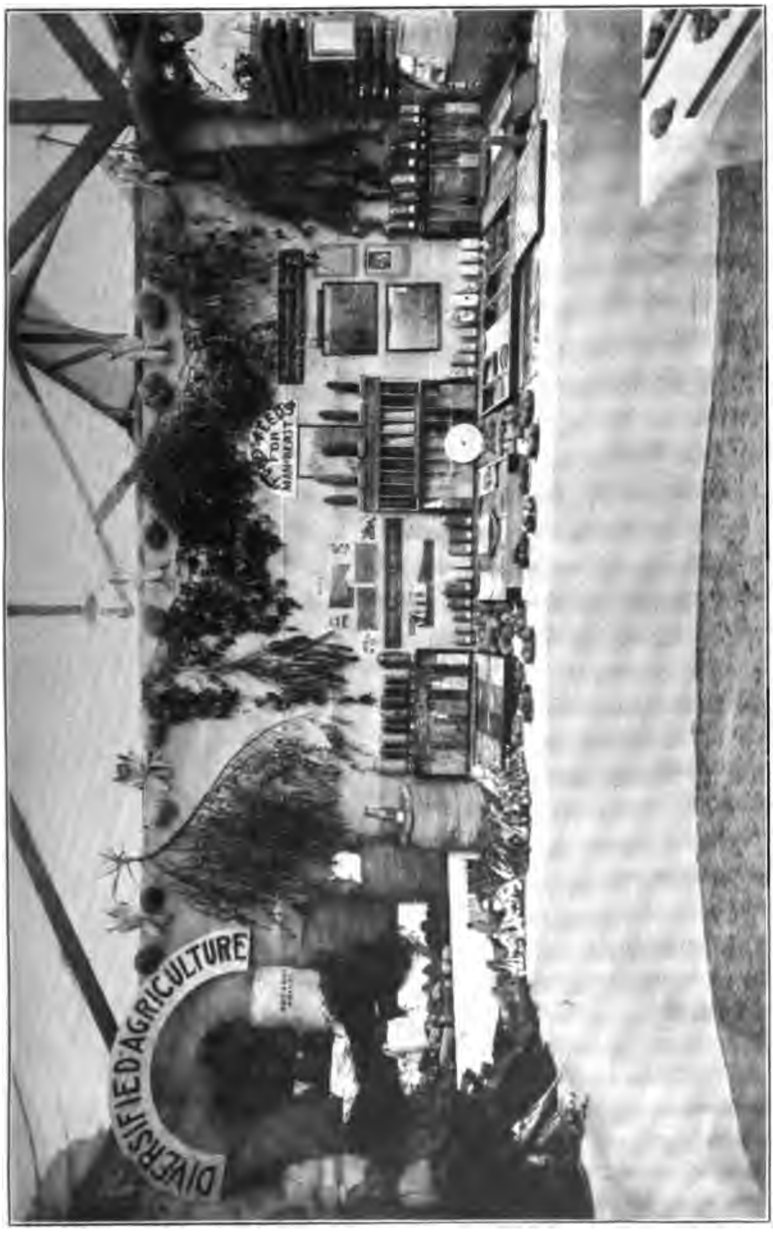
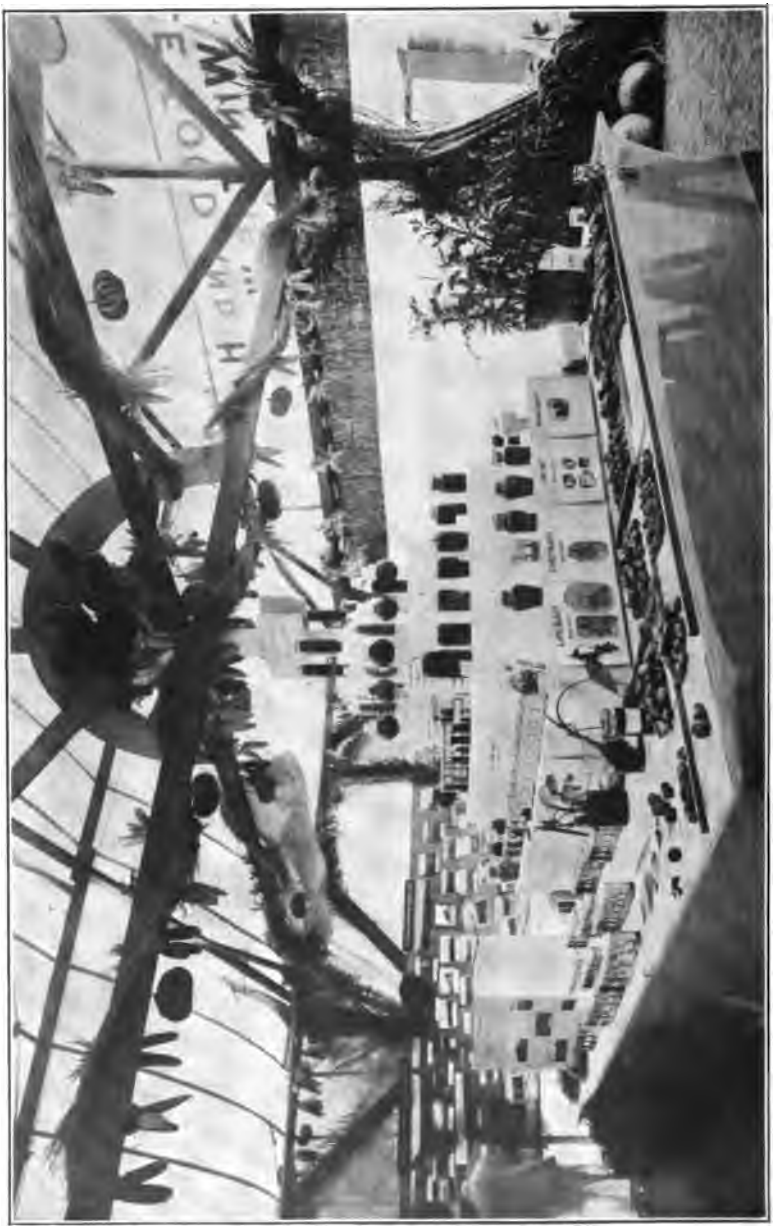


EXHIBIT OF EXTENSION DIVISION AT TERRITORIAL FAIR.

PLATE VII.



EXHIBITS OF PATHOLOGICAL (RIGHT) AND CHEMICAL (LEFT) DIVISIONS AT TERRITORIAL FAIR.

grown milled feed daily. This is designed to supplant the imported grain formerly required to feed the 1,000 head of work animals owned by the company in question

TRUCK CROPS.

During the past year, in cooperation with the Haiku Fruit and Packing Company an acre was planted to five varieties of string beans and an acre to different varieties of Lima beans. From these plantings the best varieties of each type, both for canning purposes and for yield, were determined. A representative from one of the largest mainland packing and canning concerns pronounced the Maui Red Kidney bean superior to the old Standard Refugee, Improved Stringless, and Kentucky Wonder. Among the Lima beans, the Fordhook and a special selection made by the extension division were considered the best of the five under test as regards suitability for canning.

Some progress has been made in the development of a new type of kidney bean for use where dried shell beans are desired. This work has resulted in the development of a variety which has been named the New Era Copper Kidney and which has yielded 40 per cent more beans under field conditions than any other of the numerous varieties under test. The quality also appears to be excellent.

Following up previous comparative trials of bean varieties, 100 sorts were under test during the past season, and a number of selections have been made and several crosses effected. These were shown at the recent Territorial fair, both as preserved specimens in the pod and as shelled seed.

The second annual test of some 20 varieties of onions has been completed. As in the previous test, the Bermuda type is far in the lead as to earliness, quality, and yield. However, several other varieties of long-keeping quality are giving promise, and it is believed that some may overcome the drawbacks of the Bermuda varieties.

Potatoes continue to form an important crop at the substation and demonstration farms. The third year of hill selection, both for increasing yields and obtaining a blight-resistant type, has shown some success. The fall crop of potatoes was exceptionally good where liberal applications of phosphate were made, especially in connection with the hill-selected seed. A yield of 180 bushels of marketable potatoes was obtained from one acre of Dibble's Russett, as compared with 100 bushels to the acre from unselected seed. At the present writing 23 varieties of potatoes and many selections are under test. The late blight is held in check by spraying with Bordeaux mixture. The potato industry is becoming more and more affected by the potato mite. Fortunately, lime-sulphur spray, or even sulphur alone in the proper form, is proving an effective remedy.

Much credit is due C. W. Carpenter, pathologist at the station, for the discovery of the nature of this new pest and a simple means for its suppression.

THE HOME VEGETABLE GARDEN.

The home vegetable garden has always been an important adjunct to the work with field crops at the demonstration farms at Haiku. An asparagus bed has been maintained for three years. Upland taro in several varieties is grown for household use. String beans and Lima beans are all-season crops, and a great variety of garden vegetables is grown to a less extent.

MISCELLANEOUS ACTIVITIES.

Several planting charts for field crops and vegetables have been prepared by the division for the Territorial Food Commisison, school garden officials, and others. The superintendent has also acted as judge for both the Star-Bulletin garden contest and the Maui County Fair Association garden contest. Several thousand packets of vegetable seed have been distributed where it was felt that the greatest good could be realized.

COOPERATIVE EXPERIMENTS WITH PINEAPPLES.

While the substation at Haiku since its inception has maintained a series of experiments with pineapples because of its location in an important pineapple region, it has only during the past year inaugurated an extensive project looking to the solution of the very important problems which have arisen in this industry, the importance of which is second only to that of sugar. Ten acres of pineapples is now being devoted to cultural, plant type, and fertilizer experiments with this crop. Much interest is being shown by the pineapple growers and packing companies in these experiments, and cooperation with the large pineapple companies is doing much to facilitate the progress of this work, which must necessarily take several years to complete. A number of duplications of the experiments are being voluntarily carried out by private growers, thus furnishing a source of additional data as to the response of the pineapple plants on different soil types and in different locations.

FERTILIZER DEMONSTRATIONS.

The use of superphosphate and reverted phosphate as fertilizers has shown remarkable results. The soils at Haiku show little or no benefit from lime, nitrogenous fertilizers, or potash. The use of phosphate fertilizers, however, in conjunction with green-manure crops, has given extraordinary increases in the yields of alfalfa, corn, potatoes, beans, and onions. As an indication of the value of this work, it may be mentioned that 50 tons of these phosphate fertilizers have been used during the past year in the Haiku district alone, where previously less than a ton had been used, except as an ingredient of high-grade complete fertilizers.

REPORT OF THE DIVISION OF PLANT PATHOLOGY.

By C. W. CARPENTER.

In the work of the year in the division of plant pathology, emphasis was placed on food conservation through the control of plant diseases and insect pests. In the interest of extension and demonstration work, field trips were made to all the principal islands of the Territory. The extension phase of the work was considered of paramount importance during the present emergency, and research on problems not promising prompt returns in food conservation is necessarily being held in abeyance. (Pl. VII.)

Throughout the Territory there has been a general awakening to the serious losses induced by plant pests and to the urgent need of practical control measures. The advice of the pathologist has been repeatedly sought in this emergency, and his suggestions have been faithfully carried out by the growers of food crops. The area in diversified crops was greatly increased during the year, mostly through the improvement of waste lands and the use of lands lying fallow. With those engaging in gardening for the first time in the islands, no doubt in some cases errors in judgment have led to the selection of unsuitable situations, but in the majority of cases coming to the attention of this division the failures reported were due to fungus and insect pests. Perfection in gardening was not to be expected in the first attempts, and while acquiring a knowledge of vegetable growing much has been learned of the habits of insect and fungus enemies which will be of value in the future.

The pioneer work started in 1916 by the pathologist in demonstrating insect and fungus pest control methods was continued on a much more extensive scale by the county agents. During the six months beginning with October, 1917, instructions regarding spraying were given by the county agents to 587 Japanese, 169 Chinese, 251 Hawaiians, and 639 Caucasians. In the same period, 181 demonstrations were made. The growers are coming to realize the nature of their difficulties, and enthusiasm is gradually replacing the suspicion and indifference with which the station's efforts were received in 1916. It is the aim of this division to cooperate with the county agents rather than with individuals, and all parts of the islands are now being reached promptly by station propaganda.

PUBLICATIONS.

To meet the increasing demand for information on the part of emergency gardeners, extension bulletins[1] were published on methods of combating garden pests and on bean spot disease. In the manuscript of a bulletin on the diseases of the Irish potato in Hawaii, now practically completed, the large number of diseases which affect the potato crops are described and illustrated, and methods are suggested for the amelioration of conditions. Numerous popular articles on plant diseases were contributed to the local press. During the year an article on the mite disease of potatoes was submitted for publication,[2] and an article on The Wilt Diseases of Okra and the Verticillium Wilt Problem, embracing work completed by the writer at Washington prior to coming to this station, was written and published.[3]

BANANA FRECKLE OR BLACK SPOT DISEASE.

The black spot disease of banana, mentioned in the report of this division for 1917, has spread rapidly during the year and is now a serious trouble in practically all the plantations of Chinese or dwarf bananas (*Musa cavendishii*), on the island of Oahu. The bunches of fruit from badly affected plants are undersized, discolored, and unevenly ripened, thus possibly being subject to fruitfly attack, and unsuitable for export, bringing on the local market only one-fourth to one-half the price of normal bunches. A year ago this disease appeared to be confined almost exclusively to the valley of Kalihi, where it was serious, but it could scarcely be found in Manoa Valley, 5 miles distant. It is now present to an alarming extent in the plantations of Moanalua, Pearl City, Mokuleia, and Kahaluu, as well as in Kalihi and Manoa. During a recent trip to Kalihi Valley, it was impossible to find a bunch of fruit not affected.

The Hawaiian freckle or black spot disease of the leaves and fruit (Pl. VIII, figs. 1 and 2) appears to be entirely different from the banana leaf black spot disease of Jamaica described by Ashby.[4] For this reason and to avoid confusion, the name "freckle" is suggested for the Hawaiian disease.

Whether this is a new disease in Hawaii can not be decided, though the writer inclines to this view. Somewhat similar spots originating in various ways on green fruits have been noted by the growers for a great many years. The injury caused by the red spider may be confused with the early stage of the freckle disease. The writer

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[1] Hawaii Sta. Ext. Buls. 4 and 8 (1918).

[2] Phytopathology, 8 (1918), No. 6, pp. 286–288.

[3] Jour. Agr. Research [U. S.], 12 (1918), No. 9, pp. 529–546.

[4] Ashby, S. F. Banana diseases in Jamaica. Bul. Dept. Agr. Jamaica, n. ser., 2 (1913), No. 6, pp. 109–112.

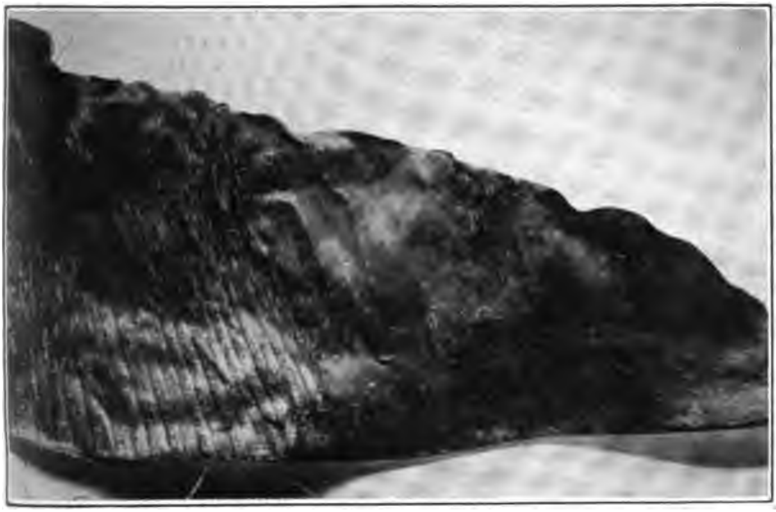


FIG. 2.—PORTION OF BANANA LEAF, SHOWING FRECKLE DISEASE.

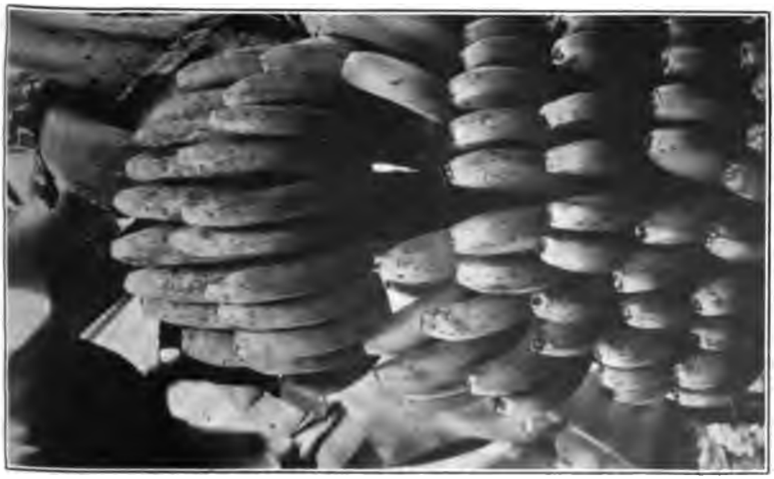
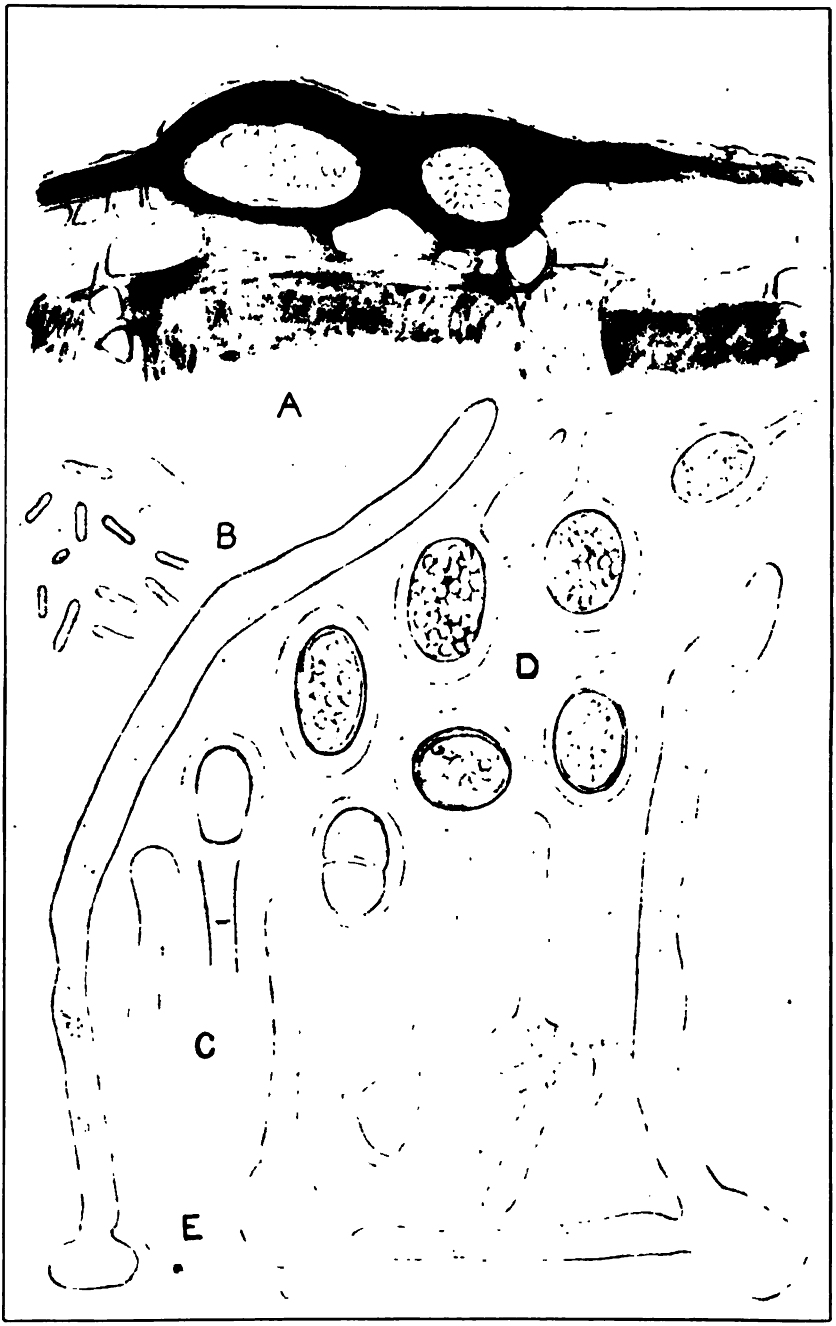


FIG. 1.—BUNCH OF GREEN CHINESE BANANAS, SHOWING FRECKLE DISEASE.



BANANA FRECKLE (PHOMA MUSÆ N. SP.).

A, Camera lucida drawing showing pycnidia and spermagonia on green fruit (× 150); B, spermatia; C, conidiophore and forming conidium; D, conidia with gelatinous envelope and appendage; E, germination of pycnospores (B, C, D, and E, × 1000).

bases his opinion that this is a new disease in Hawaii upon the following observations, as well as upon the testimony of the majority of the growers: The disease has been localized for two or more years in Kalihi; if at any time within recent years such an epidemic as is now present in Kalihi had occurred there, the growers would have retained some recollection of it; though one year ago the disease could scarcely be found in Manoa, where the conditions are similar to those in Kalihi, it is now prevalent there to an alarming extent; the plantations of Mokuleia have been free from the disease until the past few months. On the other hand there is a possibility that this disease has previously destroyed large areas of Chinese bananas in other sections of the islands. The writer is informed that this variety of bananas was once extensively planted near Hilo, but that a disease which may have been the same as the freckle disease was responsible for the abandonment of the industry there.

Since this disease appears to be new to pathologists, no record of a disease which can be determined as identical having been found, such notes as may prove valuable to a prompt diagnosis are given here in order that the spread of the disease to other countries growing Chinese or dwarf bananas may be checked if not prevented. The following description of the disease and the organism found associated with it is in the nature of a preliminary report and further investigation is required.

Defoliation, weakened plants, ultimately becoming worthless, and undersized fruit as well as undeveloped bunches which have to be cut prematurely are all results of this disease. Although in many cases the quality of the fruit seems to be unimpaired by the surface blemish, fruit bunches at all badly affected are rendered so unsightly that they are totally unsuited for export and have to be disposed of with difficulty on the local market at about one-fourth the usual price.

Under normal conditions about 230,000 bunches of bananas per year are exported to the mainland from Hawaii, almost entirely from the island of Oahu. The total annual production of this fruit in the islands is not far from 300,000 bunches. The Chinese banana, predominantly the export variety, appears to be the only sort attacked by freckle. If other plantations suffer as severely as those of Kalihi, it would seem only a matter of two or three years before no more bananas of quality suitable for export are produced. The disease, probably encouraged in the valleys by the frequent trade-wind showers, may not prove so disastrous in the outlying plantations.

Investigation has shown that the minute, black, pustule-like spots on the leaves and green fruits are subepidermal pycnidial fruiting bodies (Pl. IX, A) containing spores (Pl. IX, B, C, D, E) closely resembling the pycnospores of *Guignardia vaccinii* and *G. bidwellii.*

The fruit spots are at first minute (about 1 millimeter in diameter), grayish, rounded, and with indefinite border, suggesting small areas of extravasated sap in the surface tissues. With a hand lens the center of the spot is seen to be reddish brown in color. The spots become more definitely round and slightly erumpent as the banana develops and are jet black in color when the fruit is "full" (ready to cut). Though the pycnidia themselves are seldom confluent, they are usually present in great numbers and so closely disposed that large areas of the leaves and green fruit are blackened. In moist weather the mature pycnidia exude white gelatinous tendrils of spores. The pycnidia are not beaked, and the ostiole, though frequently plainly to be seen, is not at all conspicuous.

The pycnidia of the fungus are to be found on the upper surface of the leaves, apparently as stomatal infections and similarly on the more exposed surfaces of the fruits. On the latter they are first observed as minute grayish "freckles" on the upper surface of the upper hands of the bunch near the base of the individual fruit. In other words, the infections occur on those parts most frequently moistened by light showers and apparently where spores lodge when carried from the leaves by rain. In diameter the pycnidia are from 60 to 150μ, and most commonly about 135μ (Pl. IX, A). Spermagonia (Pl. IX, A) containing spermatia (Pl. IX, B) resembling those illustrated by Reddick[1] are also present, though less frequently than the pycnidia. The spermatia measure 2 to 7 by 1 to 2μ, or roughly ten times the figures recorded by Reddick (apparently a typographical error in placing the decimal point).

The pycnospores or conidia are ovoid, rather hyaline, inclosed in a gelatinous envelope with one appendage (Pl. IX, D), and densely packed with globular bodies (oil droplets?). The spores when first issuing from the pycnidium are commonly irregularly ovoid and angular from mutual pressure and contact. As above noted, they resemble the pycnospores of *Guignardia* spp. Disregarding the appendage and gelatinous envelope, which are not constantly present, the spores measure 11 to 17.5 by 5 to 12.2μ. Those of *G. vaccinii* are given as 10.5 to 13.5 by 5 to 6μ by Shear.[2] Those of *G. bidwellii* measure 8.5 to 11.5 by 6.5 to 8.5μ, according to Reddick.

Although the pycnospores germinate readily in sterile distilled water in one to two days (Pl. IX, E), attempts to grow the fungus on media suitable to the culture of other fungi or on several special media concocted for the purpose have thus far failed. In most cases *Glœosporium* spp. quickly develop and monopolize the medium. This failure in culturing, accompanied by the constant development of Glœosporium in the early trials, led to the impression that a species of the latter genus was responsible for the disease. Several bacteria have also been isolated from stomatal lesions, but their relation to the freckle disease remains to be determined.

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[1] Reddick, D. The black rot disease of grapes. New York Cornell Sta. Bul. 293 (1911), pp. 289-364.

[2] Shear, C. L. Cranberry diseases. U. S. Dept. Agr., Bur. Plant Indus. Bul. 110 (1907), p. 15.

Since the pycnidial fungus which appears to be constantly associated with the disease has not yet been produced in culture and as nothing is known of its perfect stage, a satisfactory description can not be furnished. Until the perfect stage shall be found, the name *Phoma musae* is suggested for the fungus.

Phoma musae n. sp. Pycnidia globose, subcoriaceous, black, immersed to slightly erumpent, separate, ostiolate, foliicolous, and fructicolous. Conidia ovoid, hyaline, closely packed with oil droplets (?), capsulated with gelatinous envelope with one appendage, one-celled, in germination sometimes apparently becoming one-septate; measuring 11 to 17.5 by 5 to 12.2 µ. Spermagonia similar to pycnidia but slightly smaller; spermatia hyaline, appearing dumb-bell shaped, 2 to 7 by 1 to 2 µ.

CONTROL.

Only those sanitary practices applicable in all plant diseases of a similar nature can be safely recommended as control measures until further investigation shall point the way. No method of control has yet shown any promise. It is believed that cleaning up and burning diseased leaves and débris, replanting suckers from healthy plants, and spraying the leaves periodically with Bordeaux mixture and thus keeping down the leaf infection until the bunch appears and matures, will tend to reduce fruit infection. The disease appears to progress slowly and would possibly be of little consequence on the fruit if the latter were not infected by the spores carried by water draining from the blackened leaves. It may be found advisable to spray the fruit with ammoniacal copper carbonate, which would be less likely to leave an objectionable stain than would the Bordeaux mixture. As banana plantations are laid out without roads and on steep hillsides in many cases, they present considerable difficulty in the practicable application of spray mixtures. Some of the plantations on level ground, if properly laid out, would offer no more mechanical difficulty in spraying, should this method of control be found desirable, than an apple orchard or an orange grove.

A fungus similar to *Phoma musae* has been found associated with a black spot disease of algaroba (*Prosopis chilensis*) pods, but this disease does not appear to be very prevalent. Other hosts of the banana fungus or similar ones are not known to occur in Hawaii. *Guignardia bidwellii*, the cause of black rot of grapes, has not been detected.

This freckle disease of the Chinese banana is a serious menace to the industry, and if not a new disease in Hawaii, it is certainly new in epidemic form. Those interested in banana growing are urged to realize the threatening aspects of this disease and to attempt control along the lines suggested and others which appear feasible, as increasing the vigor of the plants through fertilization, rotation, etc.

IRISH POTATO DISEASES.

Late blight (*Phytophthora infestans*) and wilt (*Fusarium oxysporum*) continue to be the most serious fungus diseases of the Irish potato in Hawaii. The potato tuber moth (*Phthorimaea operculella*) and the mite disease (infestation with an undetermined species of mite allied to red spider), together with the early blight disease (*Alternaria solani*), were especially destructive during the protracted drought of the summer of 1917 in the Kula and Makawao sections of Maui and in the Hamakua section of Hawaii. The early blight disease was then for the first time observed to be an important factor in Hawaiian potato culture.

MITE DISEASE.

The mite disease, an apparently new trouble of the Irish potato mentioned in the 1917 report of this division, is found to be much more widely prevalent and destructive than was at first believed. It has been observed thus far in the following localities, which furnishes a basis for the assumption that it occurs practically all over the islands at the lower elevations: Mokuleia, Castner, and Honolulu. Oahu; Kula and Makawao, Maui; Hamakua, Hawaii; and Hanalei, Kauai.

Experiment has shown that where the conditions are favorable for potato culture the mites may be kept off the plants by dusting with dry sulphur or spraying with lime-sulphur spray. The trouble may be avoided to a great extent by planting sufficiently early for the crop to mature before the dry season sets in. In any case it should be borne in mind that the Irish potato is a cool-weather crop and that during the dry season the climate of Honolulu and other localities near sea level is not well adapted to its culture. Apparently the mite disease will not prove a serious menace to the potato industry at elevations of 1,500 to 4,000 feet except in abnormally dry years. In this contingency, spraying and dusting with sulphur offers a practical means of control.

LATE BLIGHT.

During the year considerable additional evidence was accumulated showing the effectiveness of Bordeaux mixture as a preventive of late blight. Increased yields of sprayed over unsprayed plats of 50 to 200 per cent were obtained. Much of the evidence was of a nature to appeal to the eye, and accurate figures were secured in few

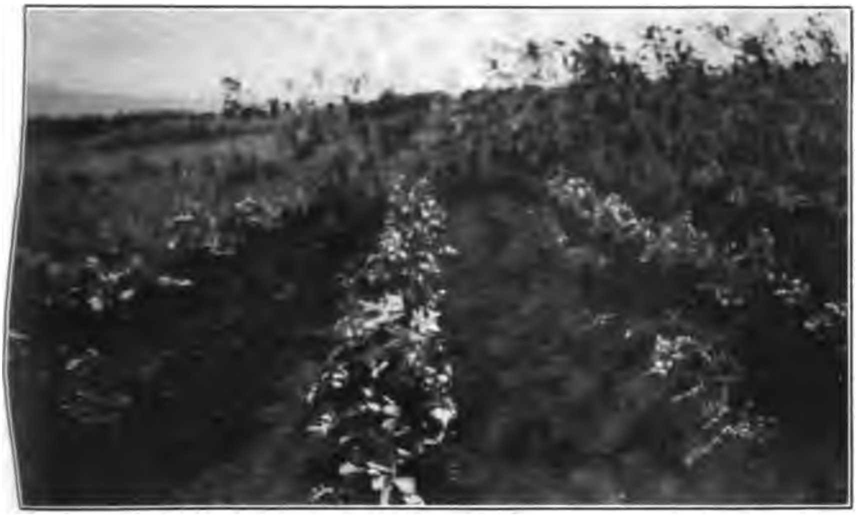
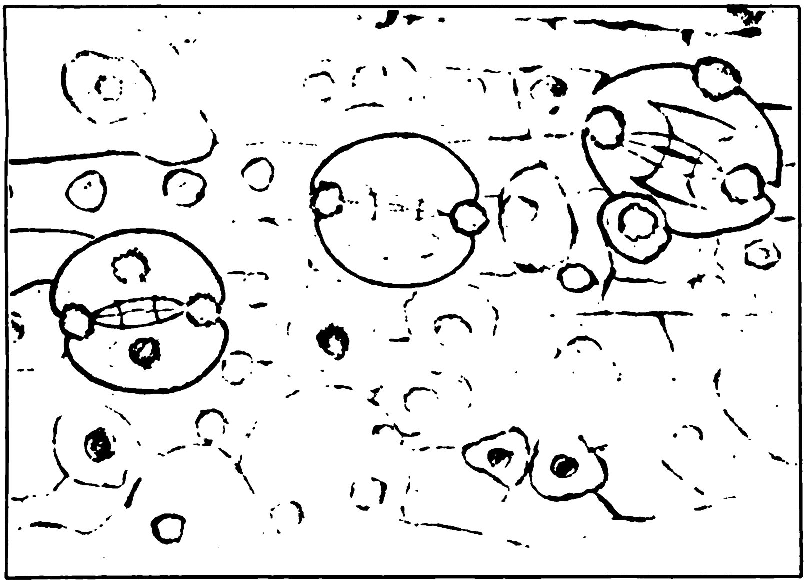


FIG. 1.—ROWS OF HAMAKUA HYBRID POTATOES RESISTANT TO LATE BLIGHT WITH BADLY BLIGHTED ROWS OF EARLY ROSE VARIETY BETWEEN.



.FIG. 2.—STOMATA OF PINEAPPLE LEAVES.

Camera lucida drawing (× 1000).

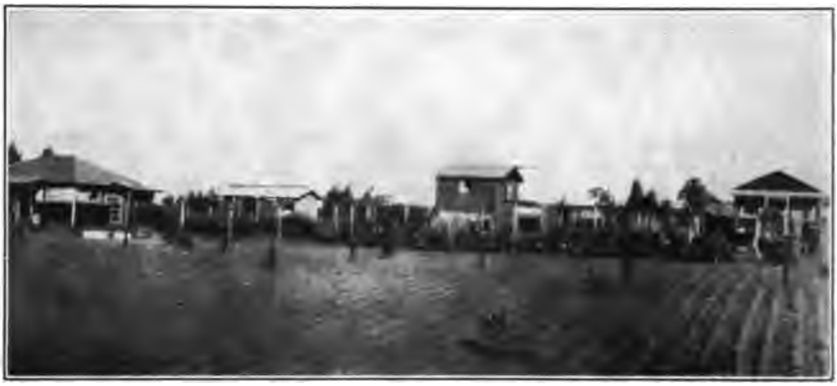


FIG. 1.—DEMONSTRATION SUBSTATION, HAIKU, MAUI.

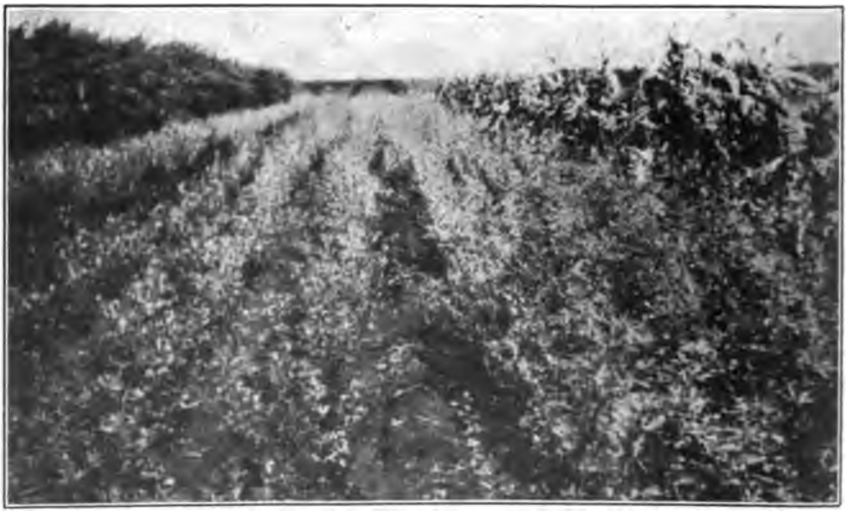


FIG. 2.—FERTILIZER EXPERIMENTS WITH ALFALFA, CASTNER SUBSTATION. FERTILIZER DRILLED IN ROWS IN CENTER, APPLIED AS SPRAY ON RIGHT.

cases. Owing to the conflicting results where badly wilt-infected stands were sprayed, some growers remain to be convinced of the efficacy of the treatment. No amount of spraying in stands badly infected with wilt (*Fusarium oxysporum*) and rosette (*Rhizoctonia* sp.) will serve to bring forth a good yield, spraying in such stands serving only to furnish a basis for criticism of spraying in general. Only in stands of potatoes worth spraying to prevent the late blight can the effectiveness of Bordeaux mixture as a preventive spray be properly appreciated. In view of the conflicting evidence of the value of Bordeaux, efforts to improve the potato industry may well center about the practice of seed selection and crop rotation for the improvement of the general vigor of the plants and the elimination of Fusarium wilt and rosette disease.

As an example of the value of Bordeaux spraying may be cited the 7-acre crop of potatoes grown this spring at Kemoo farm near Castner, Oahu. This crop was sprayed thoroughly, and although it was attacked by the late blight, this disease was held in check by prompt and effective treatment at critical times. It is estimated that this crop will yield about 85 bags per acre of as fine potatoes as can be raised anywhere.

A potato variety resistant to late blight.—A potato variety originated by Miss K. Yamato, of Honokaa, Hawaii, is reported to be much more successfully grown in that locality than any other variety tried. This type of potato, which has been called the Hamakua Hybrid from the locality where it was originated, is a composite of two sorts. One parent of both sorts appears to have been the local variety known as the Portuguese Purple, which was brought to the islands from Madeira by Portuguese emigrants. One sort appears to be the result of a natural cross between the Portuguese Purple and the Burbank type, the other a cross of the Portuguese Purple with the Early Rose variety. In conversation with the originator, it appeared that exact records were not kept, though the above is essentially her recollection of the parentage of the two strains.

The Portuguese Purple variety, though not a desirable culinary type, possesses considerable blight resistance. The Hamakua Hybrid of the Burbank type is of much better quality, though lacking mealiness in cooking and having deep eyes which cause loss in peeling. Altogether it appears to be more desirable than the other strain, or Early Rose type.

The evidence in hand indicates that the Hamakua Hybrid has a very promising degree of resistance to the Phytophthora leaf blight in these islands.[1] Experiments thus far have given conflicting results, but the writer is of the opinion that failure on the part of growers to recognize the several potato diseases, as Fusarium wilt, rosette, early blight, and mite infestation, is partly responsible for the unfavorable reports on this variety. Whether the tubers of the Hamakua variety possess resistance to the late blight rot is not known, since this phase of late blight injury is comparatively rare in Hawaii, possibly owing to its porous, well-drained soils.

At the Glenwood substation [1] two variety tests by different investigators have shown the practical value of the Hamakua Hybrid in that district, where it was successfully grown in one patch of 4 acres with a reported yield of 401 bags. The grower was so impressed with this result that he proposes to plant about 40 acres to this variety. As the Glenwood section has an annual rainfall of some 250 inches, with few days in the year without some rain, it has previously been highly discouraging to grow potatoes there, since, on account of the frequent showers and deluging rains, spraying was found to be impracticable.

The Hamakua Hybrid and the Portuguese Purple varieties have also been strikingly resistant to late blight in the cooperative tests in the gardens at Schofield Barracks, where, in order further to test the resistance of the Hamakua Hybrid, this variety was grown in comparison with the Early Rose variety. Owing to the poor soil and the lack of irrigation water, no variety yields normally there, but the differences in yield in this test are rather striking. Both varieties grew well in the first month, but at the end of 60 days the tops of the Early Rose had been destroyed by the late blight (Pl. X, fig. 1), and the 96 hills yielded only 7½ pounds of small tubers. The Hamakua Hybrid remained almost without a trace of blight through another two months of weather favorable to blight. The dry season commencing at the beginning of the fourth month, 20 hills were dug at this time, with a yield of 9½ pounds of fair-sized tubers. The rest were allowed to grow another month, but the dry soil seemed to prevent any additional growth, 58 hills yielding only 27 pounds. The average yield per hill of the Early Rose variety was 0.078 pound and for the Hamakua Hybrid 0.468 pound.

No doubt the quality of this resistant type can be greatly improved by selection and by further crosses with desirable market types. Since the Phytophthora blight is the most serious of potato diseases the world over, the practical value of a desirable market potato resistant to this disease has long been evident, and the development of such a type is the aim of investigators. Numerous varieties offering promise have been brought out in Europe, some showing considerable resistance, but they are not of the quality to win recognition on the American markets.

COFFEE DISEASES.

In Kona, Hawaii, where most of the Hawaiian coffee is grown, this crop is often considerably damaged by the sooty mold, or "fumagine," which lives saprophytically on the honeydew from certain scale insects. Whether the black fungus involved belongs to the genus Capnodium or to Meliola has not been determined. In Kona the sooty mold follows commonly the green scale (*Coccus viridis*), which is present most abundantly in dry seasons and where the coffee is grown in the open. The solution of the difficulty would appear to be in the use of proper shade trees, since the green scale is not so prevalent in the shade. Coffee does best in shade such as is afforded by silk oak (*Grevillea robusta*), the monkey pod (*Pithecolobium saman*), or other trees which do not in themselves harbor the scale, the honeydew from which would fall on the coffee foliage and nourish the molds.

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[1] Hawaii Sta. Rpt. 1917, pp. 46–48.

There is a die-back disease of coffee, as well as other troubles, in Kona, but there has been no opportunity to investigate them more than casually.

MISCELLANEOUS INSECT AND FUNGUS DISEASES.

Diseases not hitherto reported in Hawaii.—So far as is indicated by the available records, the following diseases observed during the year have not been previously reported in Hawaii:

Algaroba (*Prosopis chilensis*). Black spot of pods. Pycnidial fungus similar to organism *Phoma musae* n. sp. associated with black spot of Chinese bananas. Pycnospores appendaged, measuring 10.9 by 7.3μ. Pycnida 145 to 165μ, ostiole readily seen, 15μ in diameter.

Bean (*Phaseolus* sp.). Rust (*Uromyces appendiculatus*), leaf and pod spot (*Isariopsis griseola*).

Brassica (*Sinapis cernua*), "kai choy." White rust (*Albugo candida*).

Cactus, prickly pear (*Opuntia* sp.). Blight (*Diplodia opuntiae?*).

Carrot (*Daucus carota*). Root knot due to nematodes.

Cotton (*Gossypium* sp.) Anthracnose (*Glomerella gossypii*).

Eggplant (*Solanum melongena*). Leaf spot (*Phyllosticta hortorum*), root knot due to nematodes.

Litchi (*Litchi chinensis*). Leaf blight due to ascigerous fungus of Glomerella type.

Peanut (*Arachis hypogaea*). Wilt (*Sclerotium rolfsii*), leaf spot (*Septogloeum arachidis?*).

Rice (*Oryza sativa*). Blast (*Piricularia grisea*), stem and root disease associated with *Pythium* sp. (?).

Roselle (*Hibiscus sabdariffa*). Root disease associated with *Fusarium radicicola*.

Sorghum (*Sorghum* sp.). Smut (*Ustilago reiliana?*).

Tobacco (*Nicotiana tabacum*). Mosaic disease, root knot due to nematodes, vascular disease, Granville wilt (?).

Tomato (*Lycopersicum esculentum*). Mite disease (mite apparently the same as potato mite described on p. 40).
Potato (*Solanum tuberosum*). Early blight (*Alternaria solani*), common scab (*Actinomyces chromogenus*), tuber rot (*Fusarium coeruleum*), and tuber galls due to nematodes.
Turnip (*Brassica campestris*). Root scab (*Rhizoctonia* sp.), white rust (*Albugo candida*).

Miscellaneous fungus and insect pests.—Among other diseases and pests observed during the year were the following:

Avocado (*Persea gratissima*). Blight (*Glomerella cingulata*).
Banana (*Musa cavendishii*). Red spider.
Bean (*Phaseolus* sp.). Anthracnose (*Glomerella* (*Gloeosporium*) *lindemuthiana*).
Cabbage (*Brassica oleracea*). Webworm (*Hellula undalis*), green cabbage worm (*Pontia rapae*), bacterial soft rot.
Coffee (*Coffea* sp.). Sooty leaf mold (*Capnodium* sp.?).
Corn (*Zea mays*). Leaf hopper (*Peregrinus maidis*); motling disease similar to yellow stripe disease of corn, cause undetermined.
Guava (*Psidium guajava*). Russeting due to red spider.
Litchi (*Litchi chinensis*). Erinose (*Eriophyes* sp.).
Mango (*Mangifera* sp.). Blight, (*Glomerella cingulata*).
Monterey cypress (*Cupressus macrocarpa*). Roaches.
Onion (*Allium cepa*). Thrips.
Potato (*Solanum tuberosum*). Tuber moth (*Phthorimaea operculella*), wilt (*Fusarium oxysporum*), tuber rot (*Fusarium oxysporum* and F. *radicicola*), and rosette (*Rhizoctonia* sp.).
Pineapple (*Bromelia* sp.). Bud rot (cause?), wilts of several types apparently not caused by parasitic organisms but suggesting malnutrition.
Taro (*Colocasia* sp.). Root rots of several forms, a species of Pythium (?) associated with most common type.
Tomato (*Lycopersicum esculentum*). Blight (*Phytophthora infestans*).

STOMATA IN THE PINEAPPLE LEAF.

In a bulletin of this station[1] Wilcox and Kelly report that they were unable to find stomata in pineapple leaves, and they conclude that true stomata are not present. To quote from these writers:

> One of the peculiar features of the pineapple leaf is the apparent absence of stomata. Hundreds of sections were made from pineapple leaves and examined under the miscroscope, and portions of the epidermis of the upper and under sides of the leaves were carefully examined without finding any true

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[1] Hawaii Sta. Bul. 28 (1912), p. 9.

stomata. There are in some parts of the leaves pits in the epidermis in which much branched scale-like trichomes are attached. These structures are particularly numerous on the underside of the leaf near the base. The trichomes in question are supposed to be connected with the absorption of water.

In view of the prompt reaction of yellowed pineapple plants growing on manganese soil to a spray of iron sulphate,[1] examination of the surface and of cross sections of pineapple leaves was made several times, and in each case true stomata were found (Pl. X, fig. 2). They are located in the bottom of the furrows on the underside of the leaves and are present at an estimated average rate of 120 per square millimeter. They are not strikingly different from the stomata of other plants. None were found on the upper surfaces.

The guard cells of the pineapple stomata are in slight depressions below the surface of the bottom of the furrow. In sections mounted in water for examination with the microscope, they are obscured by an abundance of much-branched, scale-like trichomes and free scales from the latter. The included air bubbles in the scales render the stomata difficult to see. In surface sections cut from the under surface of a pineapple leaf which has been wiped with alcohol the stomata may be readily identified, and they are not especially difficult to find in cross sections of similar material.

REPORT OF THE AGRONOMY DIVISION.

By C. A. Sahr.

Problems affecting food production and conservation have constituted the chief work of this division, the lines of investigation having been gradually changed from the original projects to those more directly applicable to emergency food-crop production.

POTATOES.

Because of the very unfavorable soil conditions at the central station at Honolulu, all the work with Irish potatoes done by this division was carried out at the forage-crop station near Castner. In a test to determine the blight resistance of various standard varieties and the new Hamakua Hybrid potato, a planting was made of 16 hills each of Early Rose, Burbank, Hamakua Hybrid (Terry), Hamakua Hybrid (Haiku), and Portuguese Purple under date of February 5, 1918. Examination of these stands made April 1 disclosed the presence of late blight on the entire stands of the Burbank and Early Rose and blackened surfaces on the foliage on two plants of the Hamakua Hybrid (Haiku). The last of the Burbank stand succumbed to blight on April 18, followed by the Early Rose on April

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[1] Hawaii Sta. Press Bul. 51 (1916).

22. The two plants of the Hamakua Hybrid (Haiku) noted as bearing blackened surfaces on their foliage April 1 were the first of the blight-resistant varieties to succumb, they being recorded as dead on May 1. The entire stands of Hamakua Hybrid (Terry), Hamakua Hybrid (Haiku), and Portuguese Purple were found to be quite dead on May 10.

RICE.

The work with rice was continued at Waiau, Oahu. Due to the rice-blast disease and an as yet unidentified root disease attacking the rice, the data obtained from the aeration, fertilizer, and green manuring tests for the 1917 fall crop are unreliable. In the rotation test with rice following taro, data from two Japanese rices, Kukiruki and Okabu, were obtained. With the Kukiruki variety the increase favoring rotation amounted to 872 pounds, or 17 per cent, with the Okabu 944 pounds, or 17.7 per cent.

CORN.

Due to the many previous failures with corn caused by persistent attacks of the corn leaf hopper (*Peregrinus maidis*), the work on corn during the early portion of the past year consisted chiefly of testing numerous varieties for leaf-hopper resistance. Seed of native Guam corn received from Mr. A. C. Hartenbower, at that time agronomist in charge of the Guam Experiment Station, was planted in June, 1917, Leaming Yellow being used as a basis of comparison. While the stand of native Guam obtained was very poor, several examinations disclosed the fact that the plants of this variety appeared to be exceedingly free from leaf-hopper attacks, while the entire stand of Leaming Yellow was heavily infested. Following this discovery, the station received a donation of 15 pounds of Guam corn from E. W. H. Broadbent, of Lihue, Kauai, with which extensive planting was made August 3, 1917, together with 10 varieties received from the Bureau of Plant Industry, United States Department of Agriculture. The results of this variety test are given in the following table:

Variety tests of corn.

Variety.	Number.	Shelled corn per acre.	Variety.	Number.	Shelled corn per acre.
		Bushels.			*Bushels.*
Boone County White	1106	0	Funk's Ninety-Day	1112	13.7
Commercial White	1107	0	U. S. Select	1113	16.2
Virginia Horse Tooth	1108	0	Yellow Leaming	1114	11.8
Hickory King	1109	0	Northwestern Dent	1115	10.9
North Dakota Flint	1110	0	Native Guam		46.7
Creole	1111	39.2			

A second variety of corn (Cuban Red), a reddish-yellow sort introduced by the College of Hawaii, was likewise tested by this division at the forage crop station near Castner. While this variety also showed remarkable resistance to leaf-hopper attack, its drought-resistant qualities were found to be somewhat poor.

LEGUMES.

Two trial plantings of six varieties of button clover were made during the year. The first planting was made at the forage-crop station at Castner and the later planting in field N of the station grounds in October. In both plantings only two of the six varieties, *Medicago scutellata* (S. P. I. No. 26077) and *M. orbicularis* (S. P. I. No. 10725), made any promising growth. In both instances *M. scutellata*, while attaining considerable size, was killed off by attacks of aphids. The first growth obtained with *M. orbicularis* in the field N planting, as long as it was erect, was exceedingly promising, but as the plants became procumbent, or trailing, due to increased growth, damage caused by the wind was very evident, preventing setting of the blooms. This was further evidenced by the growth assumed by *M. orbicularis* when sown both in open places and in Bermuda-grass sod at Castner, the plants flourishing best when their trailing stems were supported and partially shaded by the grass. Other plantings of particular interest are of annual types of white sweet clover (*Melilotus alba annua*), seed of No. 1155 having been received from the Bureau of Plant Industry, United States Department of Agriculture, under F. C. I. No. 10001, and of No. 1209 from Prof. H. D. Hughes, Iowa State College. Both lots were planted at Castner, No. 1155, sown in January, coming into full bloom in early June; No. 1209, sown in April, showing favorable progress at the end of the fiscal year.

GRASSES.

Cuttings of new grasses received from the Office of Forage Crop Investigations April 24 include blue couch grass (F. C. I. No. 2378), Cayenne grass (F. C. I. No. 38746), Palm Beach grass (F. C. I. No. 02329), *Zoysia* spp. (F. C. I. No. 02839), *Capriola dactylon* (S. P. I. No. 31596), *Saccharum biflorus* (S. P. I. No. 42551), and *Andropogon emersus* (S. P. I. No. 41884). These grasses were set out in the grass garden at Castner April 30, 1918.

A sample of grass seed received under the name Prolifikeeno from John McCoy, of Fabens, Tex., was planted in two plats in field N October 2, 1917. Both plats came into full bloom in 55 days and were cut December 1, 60 days after planting, yielding at the rate of 15 and 15.7 tons green forage per acre. Its close resemblance to Johnson grass in the appearance of underground suckers shortly after cutting made it seem desirable to eradicate the stand to prevent any possibility of its spreading as a pest.

EDIBLE CANNA.

Due to the popular demand early in the year for tubers of the edible canna (*Canna edulis*) for home gardens, various plantings of this important food crop were made from time to time to serve as sources of planting material. As the plant failed to make a luxuriant growth in some of the home gardens, chiefly as a result of poor soil conditions, a fertilizer and manuring test was inaugurated. The plats, consisting of 10 hills each 3 feet apart each way, were planted September 28, 1917, and harvested June 12, 1918. The results of this experiment are given in the following table:

Fertilizer test with edible canna.

Row No.	Fertilizer applied per acre.	Yield from 10 hills.			Estimated acre yields.	
		Number of tubers.	Weight.			
			Tubers.	Tops.	Tubers.	Tops.
			Pounds.	*Pounds.*	*Tons.*	*Tons.*
1	Ammonium sulphate, 250 pounds; nitrate of soda, 150 pounds	283	170	151.5	41.14	36.66
2	Ammonium sulphate, 250 pounds; superphosphate, 250 pounds; sulphate of potash, 250 pounds	248	177	155.5	42.83	37.63
3	Check	201	117.5	79	28.43	19.11
4	Barnyard manure, 20 tons	271	169	129.5	40.9	31.34
5	Ammonium sulphate, 200 pounds; superphosphate, 100 pounds; sulphate of potash, 100 pounds	167	93	84	22.57	20.32

In conjunction with the fertilizer test with edible canna, a test was made involving two different types of tubers (cylindrical to tapering and spherical to oval), with the object of obtaining definite data on the yields from the two tuber types used as sets. The results of this test, which included 25 hills of each type, are summarized in the following table:

Comparative yields from cylindrical and spherical tubers of edible canna.

Row No.	Type of tuber.	Weight of washed roots.	Estimated acre yields.
		Pounds.	*Tons.*
1	Cylindrical	382.5	37.13
2	Spherical	335.5	32.02
	Difference	47	5.11

CASSAVA.

The various stands of White Trinidad, White Waialua, and the red, bitter cassava have been maintained in order to keep up with the demand for cuttings. Cuttings of five varieties of cassava cultivated in various provinces of the Philippine Islands and received from the

Bureau of Agriculture, Manila, P. I., in early June, are already established on the station grounds. It may be of interest to note that as cassava has become established in a great many home gardens throughout the Territory, the publication in the local press of various methods of preparation of dried cassava roots and the culinary uses of these as tested out in the household of the writer, has proved of great benefit to the public.

SWEET POTATOES.

Preliminary work with sweet potatoes was begun by this division during April, 1917, the object in view being to supply propagating material for distribution, but the demand for cuttings became so great as to make it seem advisable to broaden materially this field of work. Through the efforts of H. L. Chung, of the division of agronomy, in selection and breeding from standard types and varieties, this division is now able to distribute cuttings of varieties which are well recognized for their good producing qualities.

TIMELY ARTICLES FOR THE LOCAL PRESS.

In order to reach the people of the islands promptly with practical information along food and feed production lines, the following articles were prepared for the local press and printed during the year: Crop Protection and Fumigation, Tepary Beans, Sweet Potatoes, Rape for Hogs and Poultry, Pork Production, Aphis Control, Guam Corn, Cassava Flour, Guam Corn *v.* Seed Corn Shortage, Buckwheat, Potato Spraying by Army Gardeners, Household Uses for Cassava, Doubling Corn, Broom Corn, and Napier Grass.

FORAGE CROP AND FOOD CROP PROBLEMS AT CASTNER, OAHU.

The most important work of the year consisted in keeping an accurate record of the yields of the forage crops involved in the soil-heating and manuring test begun in 1917.[1] The first year's results with the most promising crops are given in the following table:

Comparative yields of forage crops on manganese soil given heat treatment and stable manure.

Crop.	Division A, no treatment.	Division B, ditched soil heated.	Division C, level soil burned over.	Division D, stable manure, 33 tons per acre.
Grasses:	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Rhodes	16.9	32.9	25.5	40.4
Teff	....	3.7	3	7
Sudan	.7	6.1	5.5	13.6
Wilder	3.3	7.7	8.3	20.4
Tunis	4.1	11.5	7.1	42.9
Sorghums:				
Adyiba	5.2	13.4	14.1	53.2
Sugar Drip	14.4	13.6	22.8	40.7
Legumes:				
Peruvian alfalfa	3.5	11.5	10.2	16.4
White sweet clover	1.6	7.2	7.3	13.1
Edible canna:				
Tubers	5.5	12.68	11.96	21.43
Tops	5.55	12.15	17.15	23

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[1] Hawaii Sta. Rpt. 1917, pp. 53, 54.

A further study of the effect of iron compound spray upon the yields of Peruvian alfalfa and Japanese cane is being made. In the test of applications of copperas to the alfalfa, a 0.25 per cent solution was used in each instance, first one week after each cutting and again two weeks later, after which the stands were allowed to come into full bloom before cutting. The Japanese cane was sprayed every two weeks for a period of six months, beginning in April, 1917. Following the spraying periods, the stand was laid by until harvested on April 30, 1918. The results of this work are summarized in the following table:

Effect of copperas solution upon alfalfa and Japanese cane.

Plat.	Crop.	Treatment.	Yield on— July 17, 1917.	Oct. 29, 1917.	Feb. 14, 1918.	Apr. 18, 1918.	May 16, 1918.	June 26, 1918.
			Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
I-a	Peruvian alfalfa	Sprayed	554	1,148	1,013	1,013	1,913	1,419
I-b	do	Unsprayed	459	959	593	608	1,481	432
	Increase due to spraying—per cent.		20.7	18.6	.69.1	66.6	29.1	228.4
II-a	Peruvian alfalfa	Sprayed	931	1,305	769	1,485	3,434	1,285
II-b	do	Unsprayed	809	1,244	688	1,133	2,570	1,121
	Increase due to spraying—per cent.		15	4.9	11.8	31	33.6	14.6
III-a	Japanese cane	Sprayed				7,610		
III-b	do	Unsprayed				5,291		
	Increase due to spraying—per cent.					43.5		

Due to the marked increase in the yields of alfalfa obtained as a result of spraying with copperas solutions, spraying and drilling tests were begun with other fertilizers and fertilizer solutions used in conjunction with the iron sprays (Pl. XI, fig. 2). The same alfalfa plats were used in this test as with the iron sprays alone. The check row for the iron spray of each plat was likewise check row in this test. The results of this test are given in the following table:

Effect of spraying alfalfa with iron and fertilizer compounds.

Kind, amount per acre, and method of treatment on Sept. 28, 1917.	Yield on— Sept. 29, 1917.	Feb. 14, 1918.	Apr. 8, 1918.
	Pounds.	*Pounds.*	*Pounds.*
Lime, 118 pounds:			
Drilled	1,013	243	296
Sprayed (milk of lime)	1,467	1,513	2,824
Sulphate of potash, 118 pounds:			
Drilled	945	541	594
Sprayed	1,214	971	1,254
Check:			
Drilled rows	1,930	593	608
Sprayed rows	1,244	688	1,133
Copperas, 5 pounds:			
Drilled	1,148	1,013	1,013
Sprayed	1,305	769	1,485
Superphosphate, 118 pounds			
Drilled	2,540	3,040	2,959
Sprayed	2,830	2,290	3,280

Kind, amount per acre, and method of treatment On Apr. 15, 1918.	Yield on— May 16, 1918.	June 26, 1918.
	Pounds.	*Pounds.*
Lime, 1,000 pounds:		
Drilled	523	555
Sprayed (milk of lime)	3,785	1,775
Sulphate of potash, 250 pounds:		
Drilled	6,296	432
Sprayed	2,808	1,387
Check:		
Drilled rows	1,481	432
Sprayed rows	2,570	1,121
Copperas, 5 pounds:		
Drilled	1,913	1,419
Sprayed	3,434	1,285
Superphosphate, 250 pounds:		
Drilled	2,438	5,154
Sprayed	7,593	3,084

Other work of importance was the inauguration of a fertilizer and manuring experiment with cassava and edible canna. In conjunction with this test a second fertilizer experiment without the use of manure was also inaugurated before the dry season set in.

REPORT OF THE GLENWOOD SUBSTATION.

By R. A. Goff.

The primary object of the work carried on at the Glenwood substation during the past year was to demonstrate that desirable and economic food and forage crops can be grown in the Glenwood district and to put these results directly before farmers and agricultural producers. The various nationalities represented among the growers make it difficult to distribute information through bulletins and circulars. To overcome this difficulty, two days of each week were spent in actual demonstration work among the farmers. The result has been to bring home to the local farmers the possibility of relying less on imported feeds and food crops and to depend to a greater extent on home-grown feed for stock.

DAIRY.

Glenwood has been for some time a dairy district from which considerable quantities of butter have been sent to the local markets. However, a serious difficulty in the way of successful and profitable dairy farming has been the dependence of the local dairymen on imported milled feeds to supplement the native grasses which can easily be grown in the district. Dairying is nearly always more profitable where the products grown on the farm are marketed in the form of milk or butter, but when it is necessary to import all or nearly all of the concentrates, a large share of the profit that should go to the dairyman is paid to the transportation companies and grain farmers who have produced the milled feeds. To overcome this difficulty, experiments with 20 or more forage crops have been carried on, two or three of these having given very promising results. It has been demonstrated on small plats that two crops of corn a year can be successfully grown, and when a practical method of drying the corn has been worked out, a valuable concentrate will be available for local dairymen. The small grains head out well but do not fill, and work is being done in saving the occasional grains that mature in an effort to obtain seed that will be acclimated to the region.

ALFALFA.

Alfalfa is not usually considered a concentrate, but when made into meal it is practically the equal of imported wheat bran. Work with alfalfa was carried on from the point to which it had been developed in previous years at this station. It has been demonstrated that alfalfa can be grown in this region if the cutworm and snail can be overcome, and a demonstration plat has been planted with seedlings transplanted from small flats which were protected from the rains and treated with poison mixtures applied when the plants were attacked by pests. Within a year from planting this plat had produced at the rate of over 30 tons of green feed to the acre, in spite of the fact that the distance between rows and between plants in the row was greater than would be used in actual field operations. For some time during the past year seed was planted in the flats because it was not believed possible to plant directly in the field where it would be difficult to combat cutworms on account of the heavy rainfall which promptly destroys the efficiency of any poison which can be applied. Later it was found that seed planted in small nursery beds could be protected by hand picking and other methods used in cabbage culture, and from one of these plats 5 by 75 feet enough seedlings were secured to plant an acre with the rows 2 feet apart and the plants 1 foot apart in the row. This acre is now in good condition, and practically no replanting has been necessary. After one or two trials, seed planted in rows at the distances desired for the permanent field were grown in poor soil that had been carefully fertilized, so that it is now believed that the planting in seed flats and nursery bed is unnecessary, if a time is chosen to plant when the cutworms are not plentiful. This last can be determined by observation.

As it was realized that the quickest way to get these results to planters interested in saving on their feed bills was by local demonstration, it was decided to furnish seed and assistance in planting, together with any work necessary in combating pests, to anyone who would prepare an area of sufficient size to make it worth while. At the present time these cooperative planting projects are under way in a number of places, including a homestead in Laupahoehoe, a plantation, a school attended by over 100 boys from different parts of the island, a tract owned by a cooperative planters' association at "Twelve Miles" on the Volcano Road, and two of the dairy farms in the Glenwood district. As these plantings are at elevations ranging from sea level to 4,000 feet, they will give an idea of the adaptability of alfalfa to the different climates on this island.

POTATOES.

Plantings of Irish potatoes made at various times throughout the year have shown that yields of 100 bags (100 pounds each) or more to the acre can be obtained when planting is done in the two seasons beginning in July and August and in February and March. The table given below shows the results obtained from a variety test on plats of 240 square feet started in the early part of September, 1917:

Variety test of potatoes.

Variety.	Yield from plat of 240 square feet.	Estimated acre yield.
	Pounds.	*Bags.*
Hamakua Hybrid (light variety)	59.5	108
Hamakua Hybrid (dark variety)	51.2	93
Portuguese Red	48	87.2
Eureka Extra Early	33.7	61.3
State of Maine	23.1	42
Vermont Gold Coin	19.4	35.7

The first three of the above-named varieties seem to be better adapted to the local climatic conditions and are more blight resistant. The last three consistently give lower yields, although reported to be blight resistant in the eastern part of the United States.

That the Hamakua Hybrid potato will produce as well on larger areas as on the small plats at the experiment station has been demonstrated by Mr. Yamanaka, a cane planter from "Nine Miles" on the Volcano Road, who planted 4 acres within a half-mile of the Glenwood substation and secured 408 bags of potatoes, practically all of which were of marketable size. Mr. Yamanaka now has an increased area in potatoes, and others in the Glenwood district have planted from 5 to 10 acres. The indications are that the potato industry of this region will be considerably increased in the near future.

FIBER CROPS.

Trials have been made with sisal, New Zealand flax, hemp, flax, and Manila hemp in an effort to find some crop to serve as the foundation of a fiber industry and bring into intensive and profitable cultivation some of the areas near Glenwood which can not be used for sugar-cane cultivation. With the exception of Manila hemp, all these crops have shown some promise, the flax having made an even growth and attained a height of about 3 feet.

POULTRY.

Records of pure-bred stock of Single Comb White Leghorns and Rhode Island Reds, the breeds of poultry kept at the substation, and individual trap-nest records have been continued as in past years in order to maintain high egg-laying strains by selection and to secure hatching eggs for distribution throughout the island. An artificial brooding system was built into two houses capable of housing 350 chicks at one time, and in these houses the chicks from the station incubators and chicks sent to the station for rearing have been placed. One new incubator was obtained, and 600 eggs can now be set at one time in the station incubators. A floor has been put in a house 32 by 16 feet, and this is being used for the chicks after they come from the brooders and before they are able to resist the diseases which attack them if they are allowed to run on the wet ground. Three hundred pullets hatched during the last year are beginning to lay.

Because of the prohibitive prices on imported poultry feeds, a great many farmers have disposed of their stock, and unless some of the feeds necessary can be grown on the farms those who still remain in the business may be forced to do the same. Trials are being made with grain crops such as corn, buckwheat, oats, sunflower, sorghums, and certain varieties of beans, and it is thought if some of these can be successfully grown and fed in connection with such green feeds as rape, kale, alfalfa, and clover that the imported feeds can be eliminated.

EDIBLE CANNA.

Edible canna can be used as a substitute for potato and makes an excellent food for swine. The tops, growing to a height of 8 feet or more, were fed with success to large and small pigs when the leaves and stalks were cut into 8-inch lengths and fed immediately after cutting. The entire plant is relished by hogs, which thrive on it with little other feed besides waste from the house. Plats of edible canna were planted and cultivated at the substation last year and distributed to those who wished to plant.

UPLAND RICE.

Three varieties of upland rice were planted. Two of these did not germinate, but the third is in good condition, and if some seed can be matured which will be better acclimated, the growing of this food can be introduced in the Glenwood region.

HOG FEED PRODUCTION.

That there is a possibility of raising hogs economically near Glenwood is indicated by the growth of peanuts, cassava, and edible canna at the substation. The roots of the first two and the entire plant of the last make a sufficient variety of fattening feeds to mature hogs, especially when they are pastured on alfalfa. Pure-bred hogs are being kept by four farmers in Puna, and as they have had little trouble with sickness in their herds, it appears that a good return for time and money can be realized if the planters can raise their own feeds. Approximately 1,400 pounds to the acre of peanuts in the shell was secured at the substation, while the edible canna has produced tubers at the rate of 31 tons to the acre. Yields of cassava have not been definitely ascertained, but its growth at present is promising.

BAMBOO GRASS.

Bamboo grass, a promising feed for dairy cows, has yielded over 7 tons of green feed to the acre from a 6-weeks' ratoon growth, and since it is relished by cattle, even when mature and seemingly too coarse to be appetizing, it may become a valuable feed in this region.

SWEET POTATOES.

Two varieties of sweet potatoes, the Madeira and New Era, were planted in May, 1917, and after 8 months' growth produced 90 and 125 bags of 100 pounds each to the acre, respectively. As lack of warm weather and too much wet weather seem to retard the growth of sweet potatoes in this district, they make a less profitable crop than Irish potatoes.

VEGETABLES.

Seed of 40 varieties of vegetables were obtained from a mainland seed firm and compared with similar lots of seed bought in Honolulu and on the local markets. Brussels sprouts, cabbage, carrots, salsify, cress, endive, leek, lettuce, turnips, radishes, and asparagus all made a good growth from the seed obtained in the three places, and can apparently be grown successfully here, while most other vegetable crops easily grown in the lower elevations either do not germinate or make too slow a growth to be promising.

O

TERRITORY OF HAWAII

Board of Agriculture and Forestry

DIVISION OF FORESTRY

C. S. JUDD, Superintendent.

REPORT

OF THE

Division of Forestry

FOR THE

Biennial Period Ended December 31, 1918

Reprint from the Report of the Board of Commissioners
of Agriculture and Forestry

The New Freedom Press
Honolulu, T.H.
1919

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Division of Forestry

REPORT OF THE SUPERINTENDENT OF FORESTRY

Honolulu, Hawaii, December 31, 1918.

The Board of Commissioners of
Agriculture and Forestry,
Honolulu, Hawaii.

Gentlemen: I have the honor to submit as follows the report of the Division of Forestry for the calendar years 1917 and 1918.

INTRODUCTION.

The main activities of the Division during the past two years have been largely confined to the two important branches of forest work—protection and extension. The details of this work and what has been accomplished are set forth in the following pages.

The main underlying motive for the practice of forestry in these islands is the maintenance by forest influences of a continued and steady supply of water for the use of agricultural and domestic pursuits in the Territory. The protection and rehabilitation of the forest, therefore, for the beneficial effect which it exerts on the water supply, rather than the exploitation of the forest for timber, are striven for, and any factors which work against these main objects are detrimental to the best interests and welfare of the Territory.

The sooner this principle is understood and universally practiced by all owners of forest land in the Territory, the sooner will be attained the ultimate object of forestry in these islands. This is essential because of the intimate manner in which forest lands under different ownerships are intermingled on the several islands.

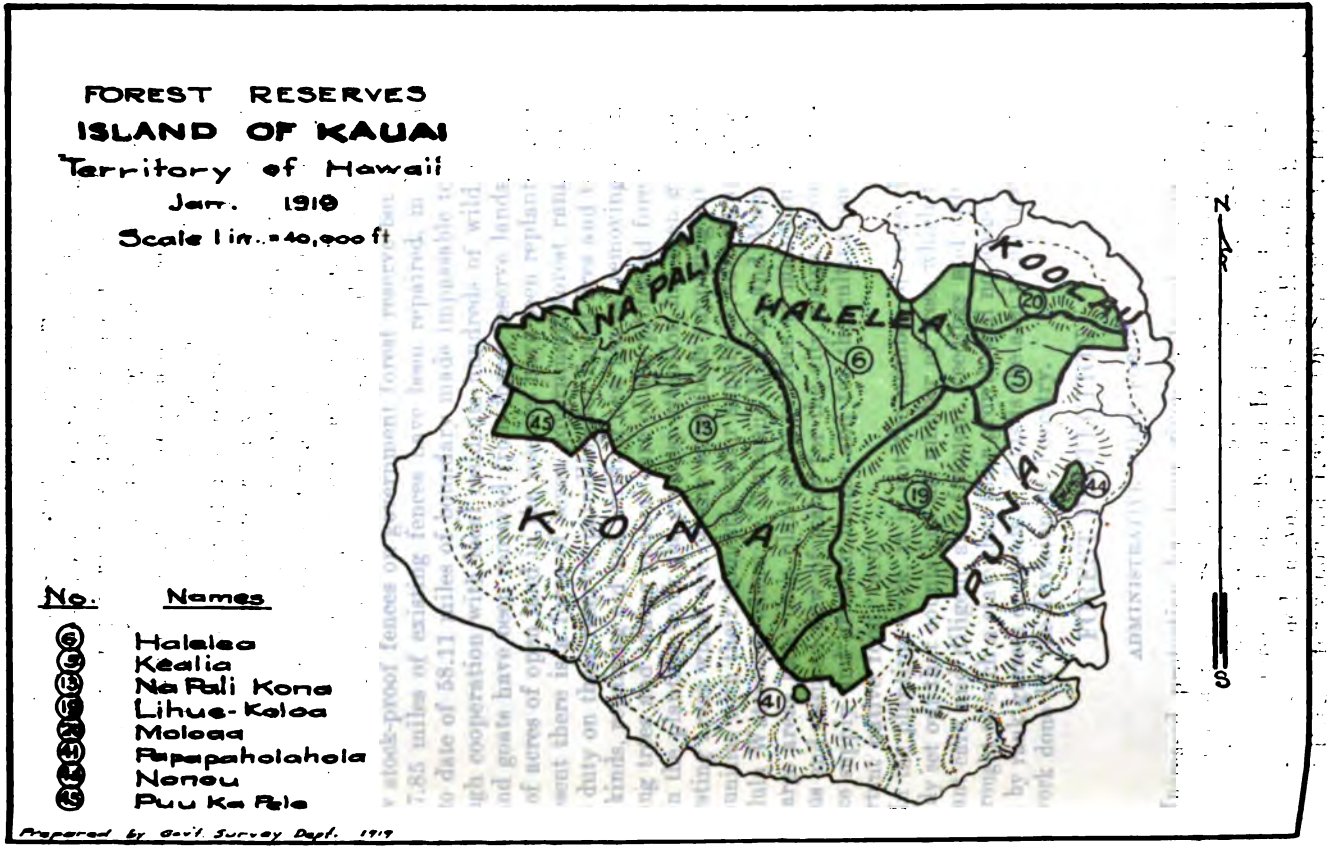
Fortunately during the past year one of the leading factors in the control of such lands, the Hawaiian Sugar Planters' Association, has seen fit to undertake the actual practice of forest protection and reforestation on forest lands under its control by establishing a Division of Forestry in its organization and by beginning work on the first unit in the Kohala Mountains. Deserved credit for the institution of this work is assigned to Commissioner W. M. Giffard, who prepared last summer a very able paper on the methods of organization for such work. The Division of Forestry of this Board will cooperate in whatever work is done by the Association wherever government forest reserve lands are involved.

In private work of this character, the Territory, represented by this Board, is more than willing to meet the private owner half-way in working out the details for any project and will gladly cooperate in any fencing project, in the employing of a ranger for mutual protection and patrol, and in nursery and reforestation projects, where government forest lands are situated on the same watershed requiring attention.

In the actual practice of forest work throughout the Territory during the past two years, several conclusions have been reached by the present incumbent at the head of the Division of Forestry which may be elucidated here. A large part of the executive work in connection not only with the demarcation of new forest reserves, which work, as will be seen later, has just been brought to a conclusion, but also with their actual field administration requires technical skill through personal effort. The simple tasks of fence repairing, driving out cattle and planting trees can be accomplished by the ordinary ranger or laborer, but the type of man at present available cannot be expected to plan and execute jobs, such as the proper selection of new nursery sites, etc., which require higher technical ability. Such work has therefore devolved upon the personal efforts of the only trained forester in this Division, and with a field of over half a million acres scattered over five different islands and separated by 360 miles of ocean and difficult land travel, not as much has been accomplished as is desired. The addition of one other technical man on the present force would make it possible to accomplish considerably more that awaits attention.

Because of the greater publicity given to the demarcation of new forest reserves through the calling of public hearings and publication of proclamations, the impression has obtained with some that this has constituted the chief work of the Division and that, when once a reserve is established on paper, further work ceases. This has been far from the truth, although in some cases it has not been possible to perform certain complete work, such as fencing, because of the disinclination of the adjacent private owner to cooperate or because of lack of adequate appropriation, or because the land under an old lease has not yet reverted to the government. It is always the plan to follow the proclamation of a new

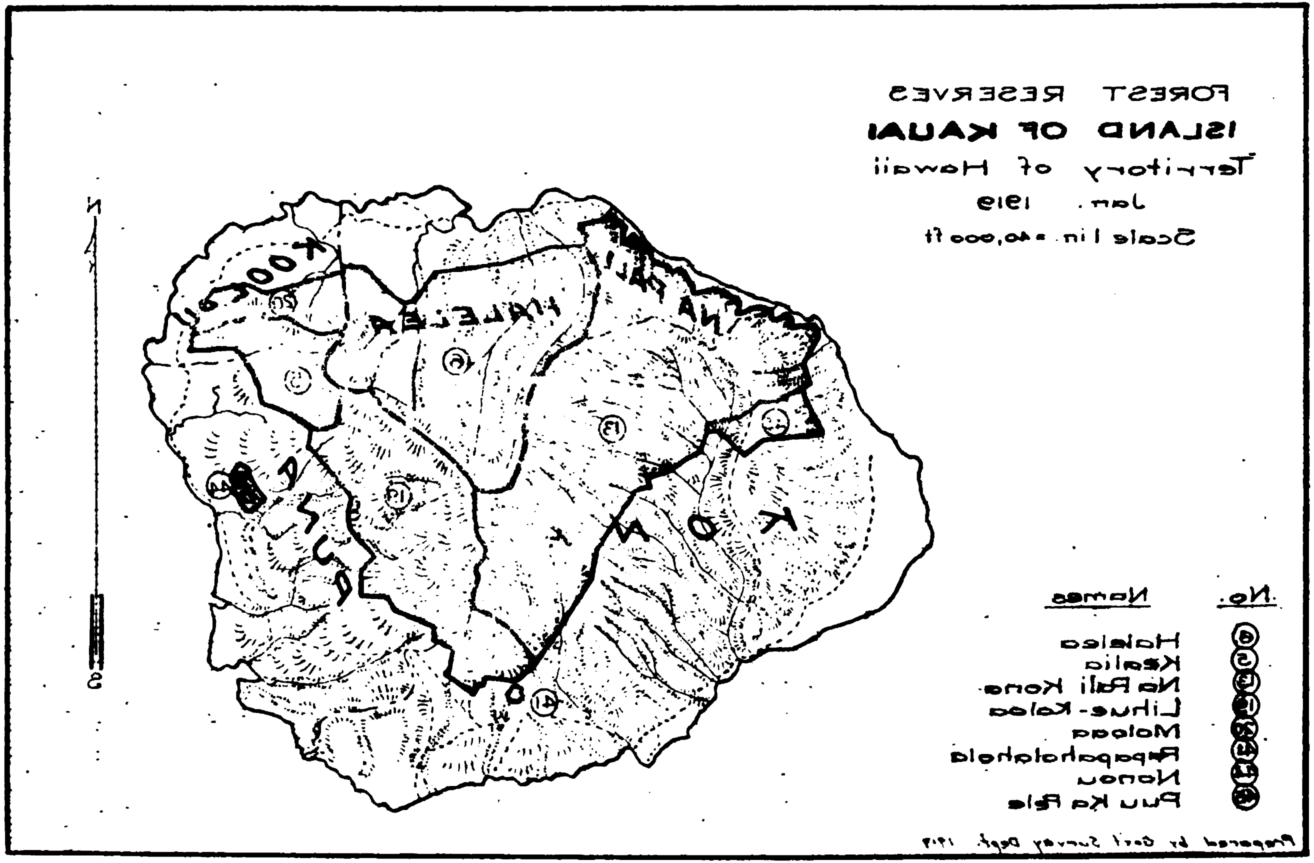
Map 1.



FOREST RESERVES
ISLAND OF KAUAI
Territory of Hawaii
Jan. 1919
Scale 1 in. = 40,000 ft

No.	Names
⑥	Halelea
⑤	Kealia
⑬	Na Pali Kona
⑲	Lihue-Koloa
⑳	Moloaa
㊶	Papapaholahola
㊹	Nonou
㊺	Puu Ka Pele

Prepared by Gov't. Survey Dept. 1919



FOREST RESERVES
ISLAND OF KAUAI
Territory of Hawaii
Jan. 1919
Scale 1 in. = 40,000 ft

reserve as speedily as possible with the necessary fencing and protection and large areas of established forest reserve lands are far from being mere paper reserves, for they are properly fenced and patrolled by rangers against trespass by man and beast, stock has been removed, and open areas have been reforested. The work of actual forest reserve administration has progressed at the same time with the establishment of new reserves.

During the past period of fourteen years since the setting apart of the first reserve, there have been constructed, through the efforts of the Division of Forestry so far as funds have permitted and through the cooperation of private owners and the Land Office by means of fencing clauses in general leases, a total of 40.26 miles of new stock-proof fences on government forest reserve boundaries and 17.85 miles of existing fences have been repaired, making a total to date of 58.11 miles of boundary made impassable to stock. Through cooperation with local residents hundreds of wild cattle, pigs and goats have been removed from forest reserve lands. Hundreds of acres of open land in the reserves have been replanted and at present there is a force of seven government forest rangers on active duty on these reserves patrolling for forest fires and trespass of all kinds, repairing old and building new fences, removing stock, planting trees and taking general care of the protected forest.

In the planting work the greatest attention has been given to reforesting areas which are on the watersheds supplying cities and communities with their domestic water supply as, for example, the Honolulu Watershed where in Nuuanu, Makiki, and Manoa Valleys large areas have been planted up to trees to maintain a continuous and assured flow of water for the city mains through the surface supply and artesian basins and for the cultivation of the important native food, taro.

In the planting work, it is not the number of trees that are actually set out that counts but the number of trees which through constant care and diligent and frequent weedings and cultivation are brought to such a state that their growth will no longer be hindered by rank grasses or weeds. This is the aim in all tree planting work done by the Division of Forestry.

FOREST PROTECTION.

ADMINISTRATIVE FIELD FORCE.

Increased protection has been given to forest reserve lands during the past two years by the appointment of an additional ranger on the island of Kauai and through certain changes in the personnel of the force. Ranger Kaina D. Lovell died on June 20, 1917, and was succeeded on August 1, by his son, Hosea K. Lovell as Forest Ranger for windward Kauai. On September 1, 1918,

W. V. Hardy was appointed Forest Ranger for Kauai in general and more particularly for the Waimea District. The three rangers for Oahu and one for Maui have remained the same with the exception of the additional appointment of Bruce Cartwright Jr. on August 1, 1917, as Honorary Forest Ranger for the enforcement of Rule IV of this Division on Oahu. On June 20, 1917, Ranger F. B. Dodge left our services to enlist in the navy and he was succeeded on September 28, 1917, by A. J. W. Mackenzie, who was appointed Forest Ranger for South Hawaii. These men have done good work in their respective districts in all lines of forest activity.

Now that the setting apart of the general forest reserve system has been accomplished, it will be possible to give greater impetus to the work of forest protection and extension in the form of fence building and tree planting. The services of two additional rangers for the Districts of Kau and Kona combined and for North Hilo, respectively, and of a ranger for the Kohala region in cooperation with the H. S. P. A. could be used to good advantage.

NEW FOREST RESERVES.

During the past two years the work of examining, describing, and setting apart forest reserves in the Territory, the essential first step in forest administration, was completed by the addition of nine new forest reserves comprising 44,476 acres, to the general reserve system, making a total of 47 reserves now established on the main islands throughout the group. These new forest reserves are as follows:

The Papapaholahola Spring Reserve in Kalaheo, Kona, Kauai, consisting of 54 acres of government land about the spring which supplies local residents with their water and most of which has already been planted up to trees by the Division of Forestry.

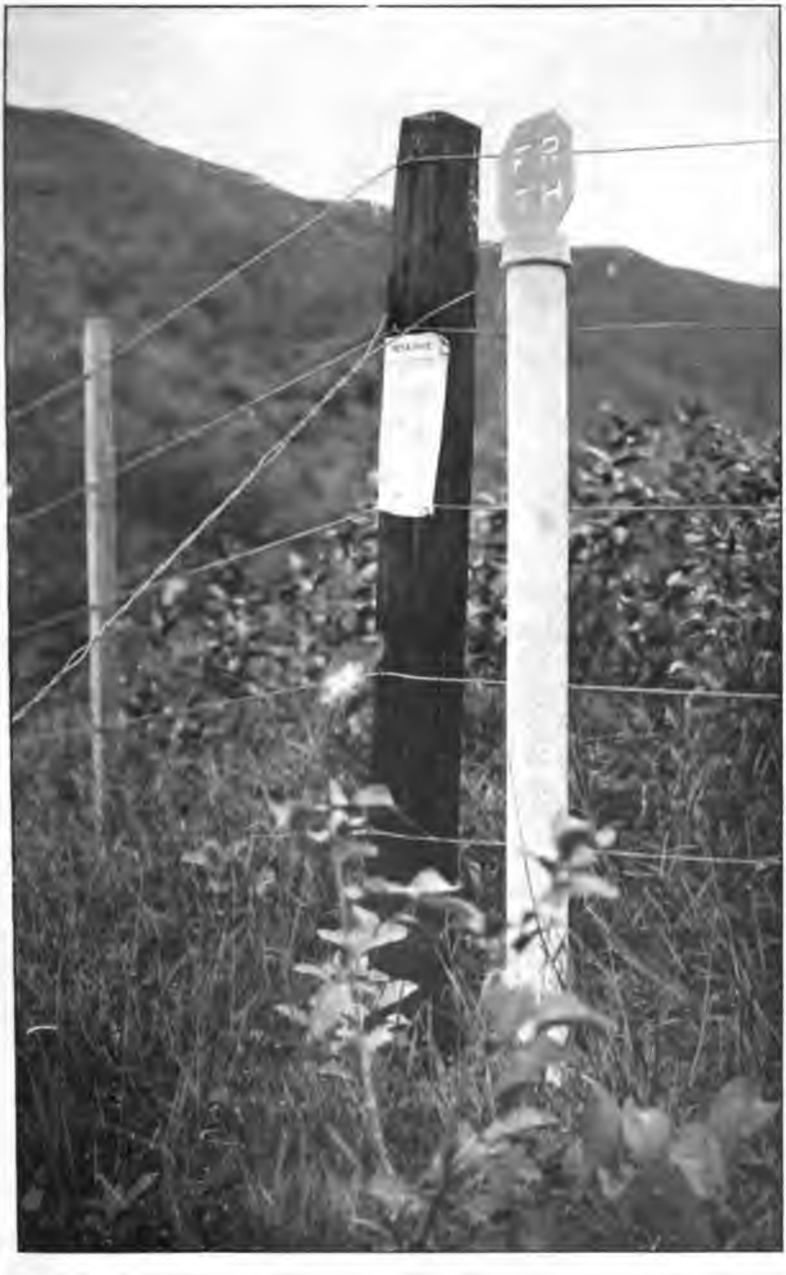
The Nonou Forest Reserve in Wailua, Puna, Kauai, consisting of 818 acres of government land on the ridge which parallels the coast and which is important for the conservation of water.

The Puu Ka Pele Forest Reserve in Waimea, Kauai, consisting of 4,900 acres of government land, which includes the scenic part of the Waimea Canyon and a large area of upland which is coming up to koa trees and is well worth protecting.

The Waiahole Forest Reserve in Koolaupoko, Oahu, consisting of 1,169 acres of which 96.5% is government land, which is important as a water-producing forest in that it embraces forest land which is a part of the Waiahole water tunnel system.

The Mokuleia Forest Reserve in Waialua, Oahu, consisting of 6,290 acres of government land above the private grants on the higher northern slopes of the Waianae Mountains which drain to

Plate 2.



Standard Forest Reserve Metal Monument and Fence,
Waiahole, Oahu.

the lower agricultural lands below where banana, rice, and sugar cane crops are irrigated by the 21 artesian wells which are supplied with water from this forested area.

The Hauula Forest Reserve, Koolauloa, Oahu, consisting of 9,193 acres, of which 12.4% is government land. This includes the government land of Hauula and the large privately owned valleys of Kaluanui, Punaluu and Kahana, which are heavily forested and are important as water producers.

The Panaewa Forest Reserve in South Hilo, Hawaii, consisting of 1,750 acres of government ohia forest extending from 4½ Miles out from Hilo along the Volcano Road to the Puna line.

The Keauohana Forest Reserve in Puna, Hawaii, consisting of 272 acres of government land bearing one of the most picturesque ohia forests on the famous drive to Kalapana.

The Olaa Forest Reserve in Puna, Hawaii, consisting of 20,030 acres of government land in the heavy wet forest of ohia, olapa, koa, loulu palms and tree ferns where homesteading has been unsuccessful and which has an important meteorological influence on the adjacent cane lands on the slopes below.

In addition to these nine new reserves, an area of 104 acres of government land was added to the Makua-Keaau Forest Reserve in Waianae, Oahu, and 263 acres of government land were added to the Makawao Forest Reserve in Hamakuapoko, Maui. On April 20, 1918, for reasons given elsewhere in this report, the island of Kahoolawe comprising 28,260 acres was withdrawn from the forest reserve and returned to the jurisdiction of the Land Commissioner and several minor withdrawals of a few acres were made for government road and exchange purposes.

The total number of forest reserves throughout the Territory is now 47, with a total area of 814,926 acres, of which 554,842 acres or 68% is government land. These are listed in the following table:

FOREST RESERVES, TERRITORY OF HAWAII.

January 1, 1919.

Name.	No.	District.	Total Area Recommended to be Reserved, Acres.	Area Govern-m't Land, Acres.	Area Private Land, Acres.	Date of Proclamation.
		ISLAND OF KAUAI.				
Halelea	6	Halelea	37,500	10,990	26,510	Aug. 24, 1914
Kealia	5	Puna	9,935	7,385	2,550	Mar. 9, 1906
Na Pali Kona	13	Na Pali and Kona	60,540	40,650	19,890	June 12, 1907
Lihue-Koloa	19	Puna and Kona	29,260	13,365	15,895	June 5, 1909
Moloaa	20	Koolau	5,621	3,578	2,043	June 5, 1909
Papapaholahola Spring	41	Kona	54	54		June 19, 1918
Nonou	44	Puna	818	818		Dec. 31, 1918
Puu Ka Pele	45	Waimea	4,900	4,900		Dec. 31, 1918
			148,628	81,740	66,888	
		ISLAND OF OAHU.				
Kaipapau	1	Koolauloa	913	913		Nov. 10, 1904
Ewa	7	Ewa, Waianae and Waialua	28,550	5,151	23,399	Mar. 9, 1906
Waianae-kai	10	Waianae	3,653	3,546	107	Sept. 7, 1906
Lualualei	11	Waianae	3,743	3,743		Nov. 30, 1906
Pupukea	21	Koolauloa	864	864		May 10, 1910
Nanakuli	28	Waialua	1,010	1,010		June 4, 1913
Makua-Keaau	29	Waialua	*4,820	4,480	340	June 4, 1913
Kuaokala	30	Waialua	434	434		June .., 1913
Honolulu Watershed	34	Honolulu	6,950	4,998	1,952	Oct. 13, 1913
Kuliouou	35	Honolulu	214	214		Feb. 13, 1914
Manoa Ranger Station	38	Honolulu	15	15		May 9, 1916
Round Top	39	Honolulu	115	115		Aug. 10, 1916
Waiahole	42	Koolaupoko	1,169	1,129	40	June 19, 1918
Mokuleia	46	Waialua	6,290	6,290		Dec. 31, 1918
Hauula	47	Koolauloa	9,193	1,143	8,050	Dec. 31, 1918

ISLAND OF MOLOKAI.

Molokai	26		44,674	13,268	31,406	Aug. 25, 1910

ISLAND OF MAUI.

Koolau	4	Koolau and Hamakualoa	42,969	30,230	12,739	Aug. 24, 1905
Hana	12	Hana	14,825	13,767	1,058	Nov. 30, 1906
West Maui	14	Lahaina, Kaanapali and Wailuku	44,482	19,147	25,335	Apr. 21, 1908
Makawao	15	Hamakuapoko	†2,093	2,093		Apr. 21, 1908
Waihou Spring	18	Hamakuapoko	84	74	10	June 5, 1909
Kula	27	Kula	6,075	5,069	1,006	Sept. 11, 1912
Kipahulu	36	Kipahulu and Kaupo	10,600	4,600	6,000	Aug. 20, 1914
			121,128	74,980	46,148	

ISLAND OF HAWAII.

Hamakua Pali	2	Hamakua	18,940	16,333	2,607	Dec. 23, 1904
Hilo	3	Hilo	110,000	60,223	49,777	July 24, 1905
Honuaula	8	Kona	665	665		Apr. 4, 1906
Kau	9	Kau	66,066	59,811	6,255	Aug. 2, 1906
Waiaha Spring	16	Kona	193	193		Apr. 21, 1908
Mauna Kea	17	Hamakua	66,600	66,600		June 5, 1909
Hauola	22	Hamakua	7	7		June 13, 1910
South Kona	24	Kona and Kau	36,952	29,260	7,692	May 17, 1911
Puna	25	Puna	19,850	19,850		June 29, 1911
Kohala Mt.	31	N. and S. Kohala	29,627	14,204	15,423	Oct. 13, 1913
Upper Waiakea	32	Hilo	51,800	51,800		Oct. 13, 1913
Upper Olaa	33	Puna	9,280	9,280		Oct. 13, 1913
Olaa Forest Park	37	Puna	531	531		Aug. 20, 1914
Panaewa	40	South Hilo	1,750	1,750		Apr. 11, 1917
Keauohana	43	Puna	272	272		June 19, 1918
Olaa	48	Puna	20,030	20,030		Dec. 31, 1918
			432,563	350,809	81,754	
TOTAL		ALL ISLANDS	814,926	554,842 (68%)	260,084 (32%)	

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*Boundary modified and area enlarged from 4,716 to 4,820 by proclamation of Governor McCarthy, Dec. 31, 1918.

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RULES AND REGULATIONS.

The rules and regulations for the protection and administration of forest reserve lands, already in force, have worked out so well that it has not been found necessary to add to them by the promulgation of any new rule. Under Rule II many permits have been issued to legitimize certain uses in forest lands, such as hunting wild game, which it was believed could be granted with due regard for the main purpose for which the reserves were created. The only arrests under our regulations were made by the police in February and March, 1918, when two men were apprehended for trespassing on the watershed in Nuuanu Valley in violation of Rule III. Each was fined $10 and costs.

PROTECTION OF BIRD LIFE.

Owing to depredations committed on certain small islands off the windward coast of Oahu, in which wild sea birds were killed for their feathers and their nests robbed of eggs, the 1917 Legislature passed Act 214 which gave this Board power to promulgate and enforce all necessary rules and regulations for the protection of bird, animal and vegetable life on the islands of Moku Manu, Moku Lua, Popoia, Manana, Kaohikaipu, Mokuhooniki and Kapapa. This Board accordingly on July 20, 1917, passed Rule IV of the Division of Forestry which was approved by the Governor on July 28, 1917, and went into effect immediately.

DIVISION OF FORESTRY.

RULE IV.

The Board of Commissioners of Agriculture and Forestry hereby make the following rule and regulation for the protection of bird, animal and vegetable life on certain islands of the Territory of Hawaii.

Section 1. It is unlawful for any person to hunt, trap, capture, wilfully disturb or kill any bird or any animal of any kind whatever, or to take, injure or destroy the eggs of any bird, or to cut, chop, burn, injure or destroy any vegetation on the islands of Moku Manu, Moku Lua, Popoia, Manana, Kaohikaipu, Mokuhooniki and Kapapa, except as authorized by written permit from the Superintendent of Forestry.

Section 2. The going on or being on said islands with intent to destroy, molest, disturb, or injure any bird, animal or vegetable life thereon without a written permit from the Superintendent of Forestry is forbidden and declared to constitute trespass punishable by fine.

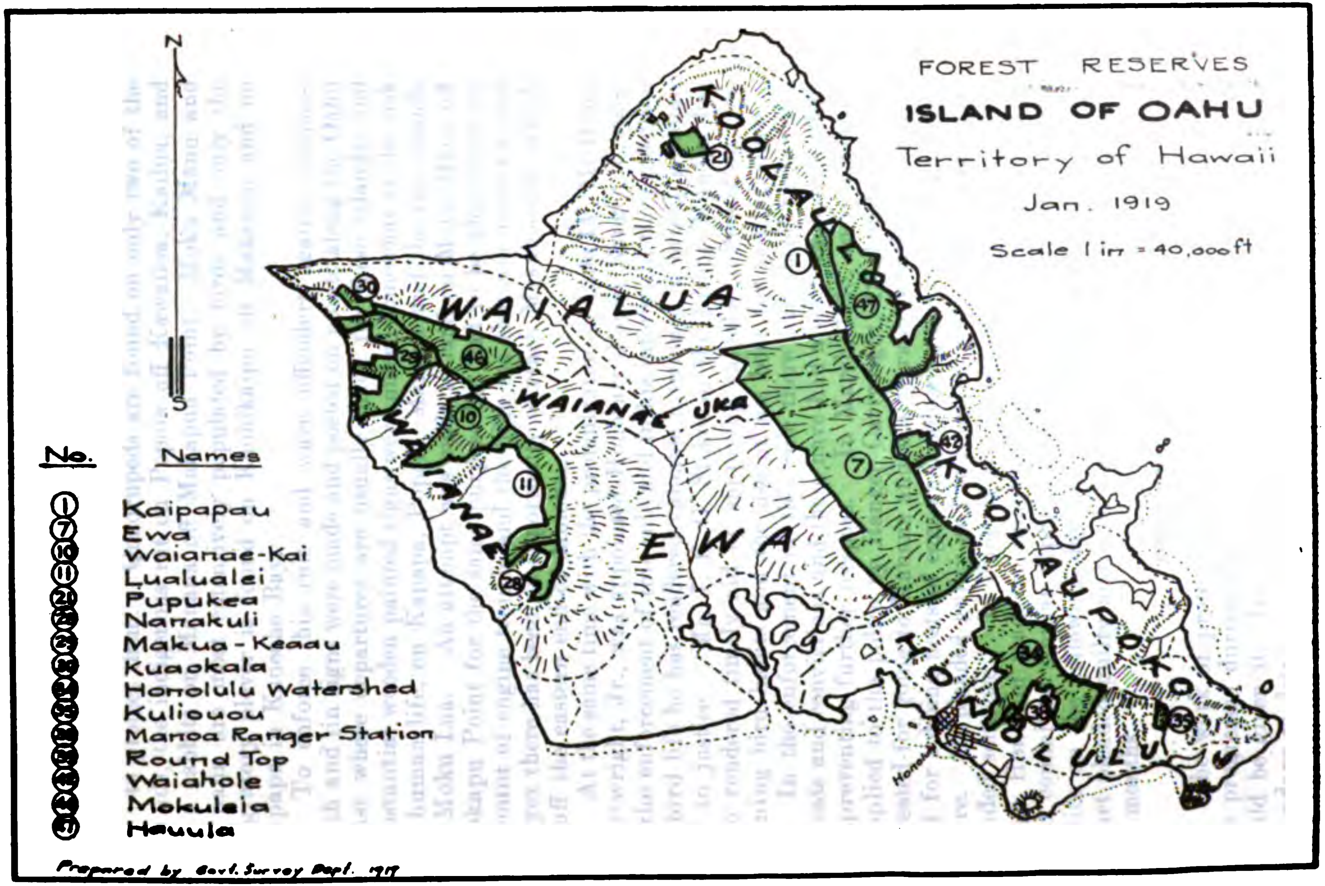
Section 3. Any person violating the above rule shall be guilty of a misdemeanor and upon conviction thereof shall be punished by a fine not to exceed Five Hundred Dollars ($500.00), as provided by Section 529, Revised Laws of Hawaii of 1915.

This rule shall take effect upon its approval by the Governor of Hawaii.

Approved this 28th day of July, 1917.

LUCIUS E. PINKHAM,
Governor of Hawaii.

Honolulu, Territory of Hawaii.



FOREST RESERVES

ISLAND OF OAHU

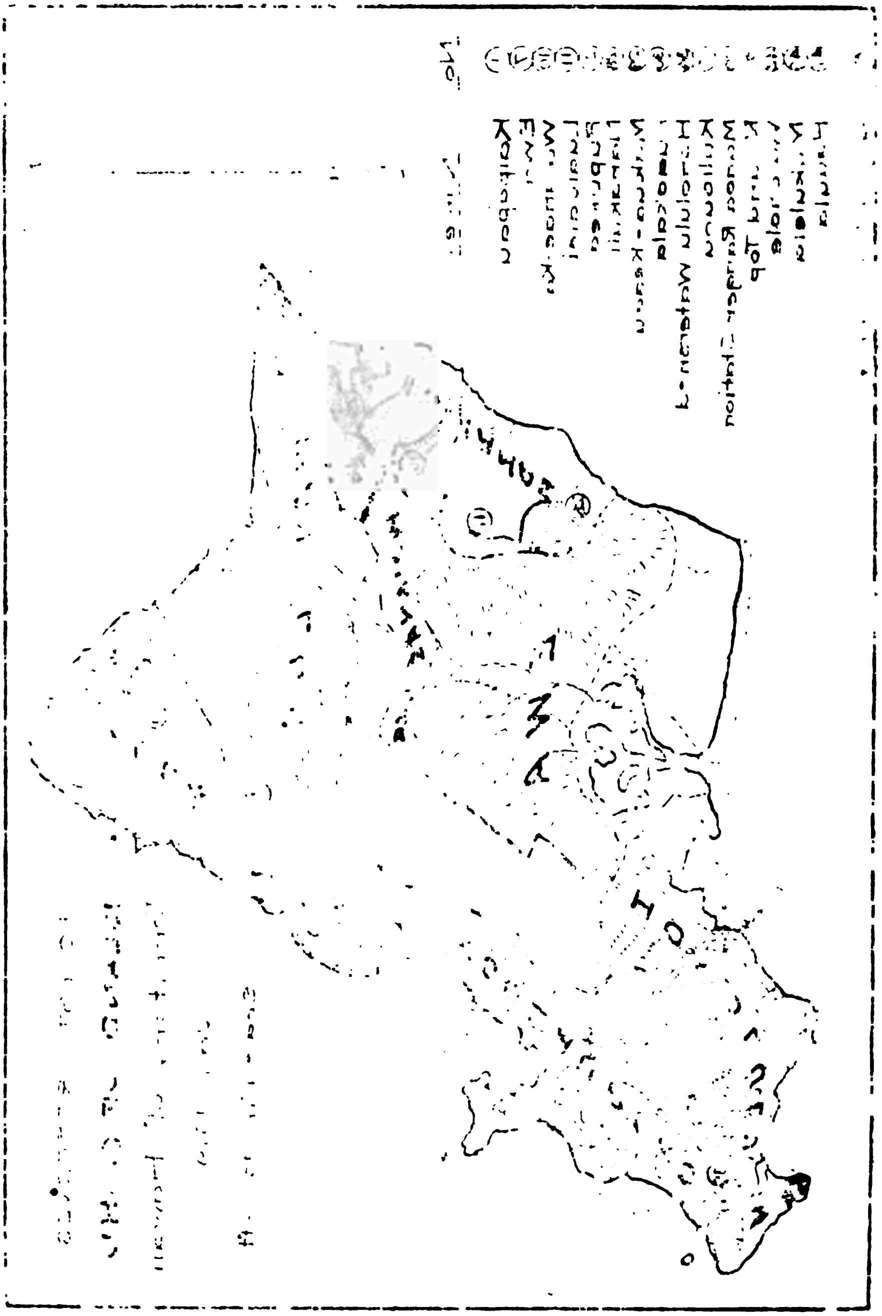
Territory of Hawaii

Jan. 1919

Scale 1 in = 40,000 ft

No.	Names
①	Kaipapau
⑦	Ewa
⑩	Waianae-Kai
⑪	Lualualei
㉑	Pupukea
[illegible]	Nanakuli
[illegible]	Makua-Keaau
[illegible]	Kuaokala
[illegible]	Honolulu Watershed
[illegible]	Kuliouou
[illegible]	Manoa Ranger Station
[illegible]	Round Top
[illegible]	Waiahole
[illegible]	Mokuleia
[illegible]	Hauula

Prepared by Govt. Survey Dept. 1917



The birds consisting largely of the petrel and frigate bird which nest on these small rocky islands are sea scavengers and may therefore be considered beneficial, and for this reason it is desirable to protect them. Quadrupeds are found on only two of the islands, the indigenous rat on Popoia off Kawailoa, Kailua, and wild rabbits on Manana off Makapuu Point. Moku Manu and Manana are most extensively populated by birds and only the migratory plover is found on Kaohikaipu off Makapuu and on Kapapa in Kaneohe Bay.

To enforce this rule and warn offenders against trespass, cloth and tin signs were made and posted on points along the Oahu coast where departures are usually made for these islands, and substantial wooden painted signs were placed somewhat at the risk of human life, on Kapapa, Popoia, Manana and the two islands of Moku Lua. An attempt was made to land on Moku Manu off Mokapu Point for the same purpose but had to be abandoned on account of engine trouble and the high sea that was running, and as yet there has been no opportunity to reach Mokuhooniki, which is off the eastern end of Molokai.

At the same time with the promulgation of Rule IV. Mr Bruce Cartwright, Jr., was appointed Honorary Forest Ranger to assist in the enforcement of this rule and in his interest in the protection of bird life he has rendered valuable assistance in bringing violators to justice. Mr. J. F. G. Stokes of the Bishop Museum has also rendered timely aid by supplying valuable information concerning bird habits and the use of his boat for posting signs.

In the enforcement of this rule there have been twenty-two arrests and convictions and these have had a very wholesome effect in preventing further trespass. In March, 1918, on information supplied to the police by Ranger Cartwright, 13 chauffeurs were arrested for going to Manana and killing rabbits without a permit and for robbing nests of eggs and molesting the birds which breed there. All pleaded guilty and were given a thirteen months' suspended sentence. In June of the same year, nine other people from Honolulu made an unauthorized visit to the same island and committed similar depredations. They were arrested by the police on the following day and upon appearance in the police court pleaded guilty and each was given a suspended sentence of 13 months.

FOREST FENCING.

The work of protecting forest reserve boundaries by fencing has progressed during the past two years as rapidly as attention could be given it. In most cases a personal examination of the boundary to determine just where the fence should be constructed and the amount of material required is necessary, and where pri-

vate land is involved negotiations must be made with the owner for cooperative fencing. Owing to the nature of the land short stretches of fence across a valley or over a ridge will protect large areas further back on the mountains and so far as possible the lines of new forest reserve boundaries have been laid out so that natural barriers, impassable to stock, are taken advantage of. In addition to the construction of new fences, attention has been given as well to the repairing of existing fences, for in this manner stock can effectively be kept out of a forest at comparatively small expense and a fence is not worth much unless it is stockproof.

The anthrax outbreaks which required my personal attention for several months during 1917 interfered somewhat with the fencing program. Many of the boundaries to be fenced are situated in out of the way places where it is hard to transport the posts and wire and where labor is scarce and hard to obtain, but it was found possible through the efforts of this Division and cooperation with private owners and the Land Office to construct during the biennial period 14.42 miles of new fence and repair 4.21 miles of existing fences on forest reserve boundaries, making a total of 18.63 miles of boundary adequately protected by the necessary stockproof fences.

The fencing work in detail during the past two years was as follows:

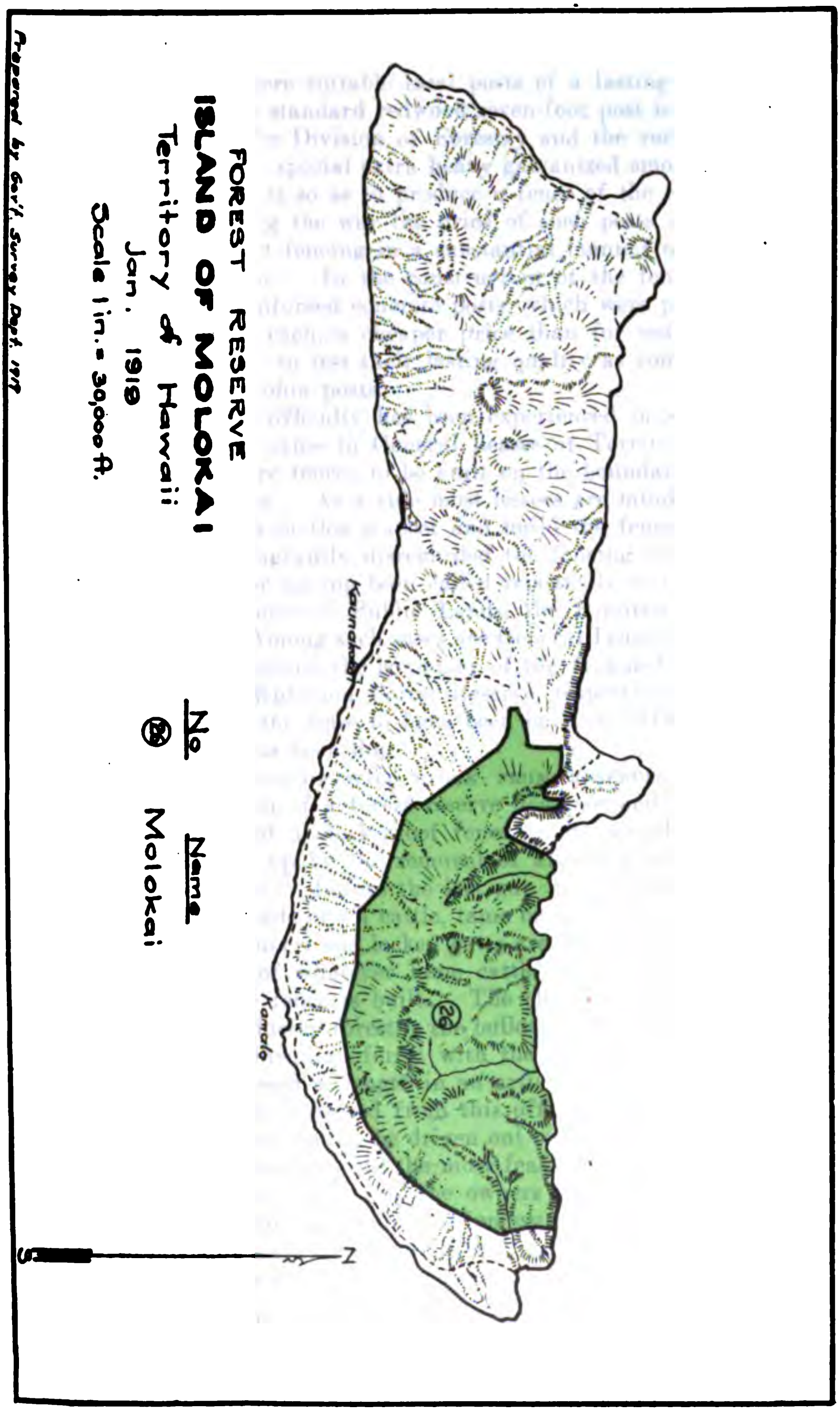
FENCES CONSTRUCTED, 1917-1918.

Date Completed.	Island.	Reserve.	Location	Length (miles)
May, 1917	Oahu	Honolulu Watershed	Makiki	.08
Sept., 1917	Hawaii	Olaa Forest Park	Olaa	.48
Nov., 1917	Oahu	Nanakuli	Nanakuli	1.35
Dec., 1917	Hawaii	Hilo	Laupahoehoe	2.78
May, 1918	Hawaii	Hilo	Piha	3.42
July, 1918	Oahu	Waianae-kai	Waianae	.22
Aug., 1918	Maui	Makawao	Makawao	.89
Sept., 1918	Oahu	Waiahole	Waiahole	.59
Sept., 1918	Oahu	Hauula	Hauula	1.05
Dec., 1918	Hawaii	Olaa Forest Park	Glenwood	3.56
			Total	14.42

FENCES REPAIRED, 1917-1918.

Date Completed.	Island.	Reserve.	Location	Length (miles)
April, 1917	Oahu	Honolulu Watershed	Nuuanu	.37
June, 1918	Oahu	Pupukea	Pupukea	1.19
Aug., 1918	Maui	Makawao	Makawao	.53
Nov., 1918	Maui	Makawao	Olinda	1.31
Dec., 1918	Oahu	Waiahole	Waiahole	.81
			Total	4.21

Biennial Report, 1918, Board of Agriculture and Forestry. Map III.



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Moloaa	20	Koolau	5,621	3,578	2,043	June 5, 1909
Papapaholahola Spring	41	Kona	54	54		June 19, 1918
Nonou	44	Puna	818	818		Dec. 31, 1918
Puu Ka Pele	45	Waimea	4,900	4,900		Dec. 31, 1918
			148,628	81,740	66,888	
		ISLAND OF OAHU.				
Kaipapau	1	Koolauloa	913	913		Nov. 10, 1904
Ewa	7	Ewa, Waianae and Waialua	28,550	5,151	23,399	Mar. 9, 1906
Waianae-kai	10	Waianae	3,653	3,546	107	Sept. 7, 1906
Lualualei	11	Waianae	3,743	3,743		Nov. 30, 1906
Pupukea	21	Koolauloa	864	864		May 10, 1910
Nanakuli	28	Waialua	1,010	1,010		June 4, 1913
Makua-Keaau	29	Waialua	*4,820	4,480	340	June 4, 1913
Kuaokala	30	Waialua	434	434		June .., 1913
Honolulu Watershed	34	Honolulu	6,950	4,998	1,952	Oct. 13, 1913
Kuliouou	35	Honolulu	214	214		Feb. 13, 1914
Manoa Ranger Station	38	Honolulu	15	15		May 9, 1916
Round Top	39	Honolulu	115	115		Aug. 10, 1916
Waiahole	42	Koolaupoko	1,169	1,129	40	June 19, 1918
Mokuleia	46	Waialua	6,290	6,290		Dec. 31, 1918
Hauula	47	Koolauloa	9,193	1,143	8,050	Dec. 31, 1918

ISLAND OF MOLOKAI.

Molokai	26		44,674	13,268	31,406	Aug. 25, 1910

ISLAND OF MAUI.

Koolau	4	Koolau and Hamakualoa	42,969	30,230	12,739	Aug. 24, 1905
Hana	12	Hana	14,825	13,767	1,058	Nov. 30, 1906
West Maui	14	Lahaina, Kaanapali and Wailuku	44,482	19,147	25,335	Apf. 21, 1908
Makawao	15	*Hamakuapoko	†2,093	2,093		Apr. 21, 1908
Waihou Spring	18	Hamakuapoko	84	74	10	June 5, 1909
Kula	27	Kula	6,075	5,069	1,006	Sept. 11, 1912
Kipahulu	36	Kipahulu and Kaupo	10,600	4,600	6,000	Aug. 20, 1914
			121,128	74,980	46,148	

ISLAND OF HAWAII.

Hamakua Pali	2	Hamakua	18,940	16,333	2,607	Dec. 23, 1904
Hilo	3	Hilo	110,000	60,223	49,777	July 24, 1905
Honuaula	8	Kona	665	665		Apr. 4, 1906
Kau	9	Kau	66,066	59,811	6,255	Aug. 2, 1906
Waiaha Spring	16	Kona	193	193		Apr. 21, 1908
Mauna Kea	17	Hamakua	66,600	66,600		June 5, 1909
Hauola	22	Hamakua	7	7		June 13, 1910
South Kona	24	Kona and Kau	36,952	29,260	7,692	May 17, 1911
Puna	25	Puna	19,850	19,850		June 29, 1911
Kohala Mt.	31	N. and S. Kohala	29,627	14,204	15,423	Oct. 13, 1913
Upper Waiakea	32	Hilo	51,800	51,800		Oct. 13, 1913
Upper Olaa	33	Puna	9,280	9,280		Oct. 13, 1913
Olaa Forest Park	37	Puna	531	531		Aug. 20, 1914
Panaewa	40	South Hilo	1,750	1,750		Apr. 11, 1917
Keauohana	43	Puna	272	272		June 19, 1918
Olaa	48	Puna	20,030	20,030		Dec. 31, 1918
			432,563	350,809	81,754	
	TOTAL	ALL ISLANDS	814,926	554,842 (68%)	260,084 (32%)	

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*Boundary modified and area enlarged from 4,716 to 4,820 by proclamation of Governor McCarthy, Dec. 31, 1918.

†Boundary modified and area enlarged from 1,830 to 2,093 by proclamation of Governor Pinkham, June 19, 1918.

RULES AND REGULATIONS.

The rules and regulations for the protection and administration of forest reserve lands, already in force, have worked out so well that it has not been found necessary to add to them by the promulgation of any new rule. Under Rule II many permits have been issued to legitimize certain uses in forest lands, such as hunting wild game, which it was believed could be granted with due regard for the main purpose for which the reserves were created. The only arrests under our regulations were made by the police in February and March, 1918, when two men were apprehended for trespassing on the watershed in Nuuanu Valley in violation of Rule III. Each was fined $10 and costs.

PROTECTION OF BIRD LIFE.

Owing to depredations committed on certain small islands off the windward coast of Oahu, in which wild sea birds were killed for their feathers and their nests robbed of eggs, the 1917 Legislature passed Act 214 which gave this Board power to promulgate and enforce all necessary rules and regulations for the protection of bird, animal and vegetable life on the islands of Moku Manu, Moku Lua, Popoia, Manana, Kaohikaipu, Mokuhooniki and Kapapa. This Board accordingly on July 20, 1917, passed Rule IV of the Division of Forestry which was approved by the Governor on July 28, 1917, and went into effect immediately.

DIVISION OF FORESTRY.

RULE IV.

The Board of Commissioners of Agriculture and Forestry hereby make the following rule and regulation for the protection of bird, animal and vegetable life on certain islands of the Territory of Hawaii.

Section 1. It is unlawful for any person to hunt, trap, capture, wilfully disturb or kill any bird or any animal of any kind whatever, or to take, injure or destroy the eggs of any bird, or to cut, chop, burn, injure or destroy any vegetation on the islands of Moku Manu, Moku Lua, Popoia, Manana, Kaohikaipu, Mokuhooniki and Kapapa, except as authorized by written permit from the Superintendent of Forestry.

Section 2. The going on or being on said islands with intent to destroy, molest, disturb, or injure any bird, animal or vegetable life thereon without a written permit from the Superintendent of Forestry is forbidden and declared to constitute trespass punishable by fine.

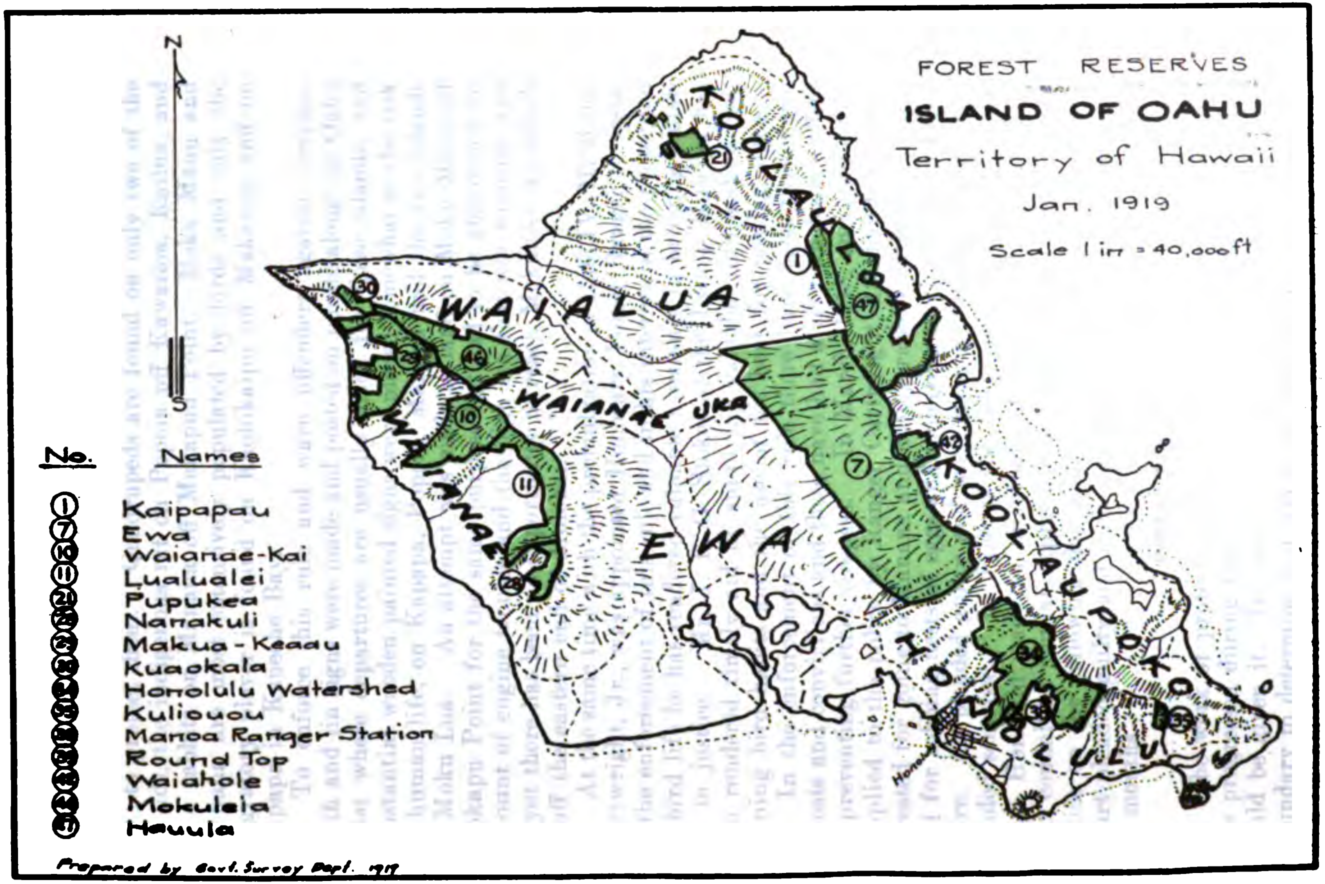
Section 3. Any person violating the above rule shall be guilty of a misdemeanor and upon conviction thereof shall be punished by a fine not to exceed Five Hundred Dollars ($500.00), as provided by Section 529, Revised Laws of Hawaii of 1915.

This rule shall take effect upon its approval by the Governor of Hawaii.

Approved this 28th day of July, 1917.

LUCIUS E. PINKHAM,
Governor of Hawaii.

Honolulu, Territory of Hawaii.


FOREST RESERVES
ISLAND OF OAHU
Territory of Hawaii
Jan. 1919
Scale 1 in = 40,000 ft
N
S
No.
Names
① Kaipapau
⑦ Ewa
⑩ Waianae-Kai
⑪ Lualualei
㉑ Pupukea
Nanakuli
Makua - Keaau
Kuaokala
Honolulu Watershed
Kuliouou
Manoa Ranger Station
Round Top
Waiahole
Mokuleia
Hauula
WAIALUA
WAIANAE UKA
WAIANAE
EWA
KOOLAULOA
KOOLAUPOKO
HONOLULU
Honolulu
①
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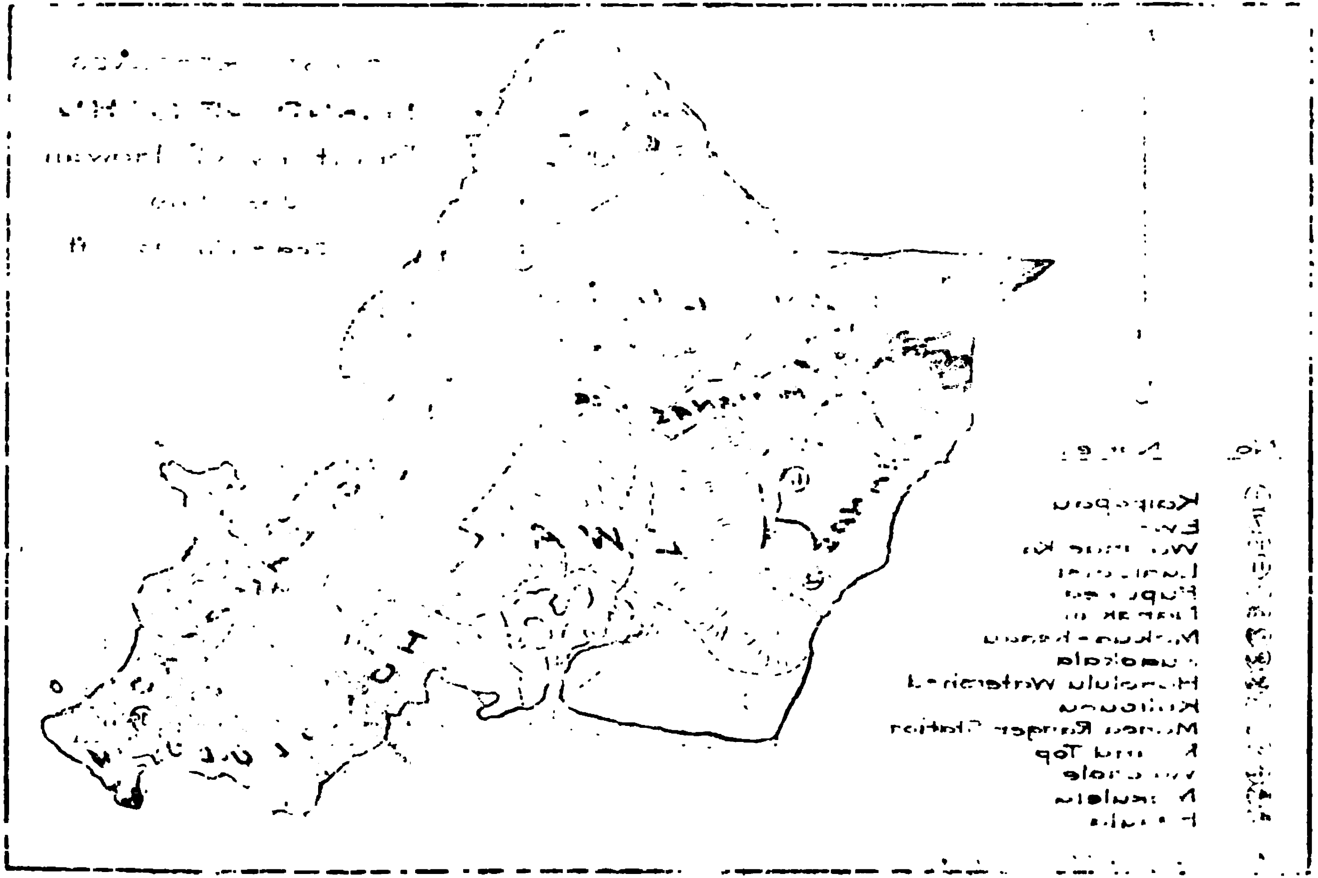
Prepared by Govt. Survey Dept. 1919


No.
Name
Kaipapau
Ewa
Makua-Keaau
Honolulu Watershed
Kuliouou
Top

The birds consisting largely of the petrel and frigate bird which nest on these small rocky islands are sea scavengers and may therefore be considered beneficial, and for this reason it is desirable to protect them. Quadrupeds are found on only two of the islands, the indigenous rat on Popoia off Kawailoa, Kailua, and wild rabbits on Manana off Makapuu Point. Moku Manu and Manana are most extensively populated by birds and only the migratory plover is found on Kaohikaipu off Makapuu and on Kapapa in Kaneohe Bay.

To enforce this rule and warn offenders against trespass, cloth and tin signs were made and posted on points along the Oahu coast where departures are usually made for these islands, and substantial wooden painted signs were placed somewhat at the risk of human life, on Kapapa, Popoia, Manana and the two islands of Moku Lua. An attempt was made to land on Moku Manu off Mokapu Point for the same purpose but had to be abandoned on account of engine trouble and the high sea that was running, and as yet there has been no opportunity to reach Mokuhooniki, which is off the eastern end of Molokai.

At the same time with the promulgation of Rule IV. Mr Bruce Cartwright, Jr., was appointed Honorary Forest Ranger to assist in the enforcement of this rule and in his interest in the protection of bird life he has rendered valuable assistance in bringing violators to justice. Mr. J. F. G. Stokes of the Bishop Museum has also rendered timely aid by supplying valuable information concerning bird habits and the use of his boat for posting signs.

In the enforcement of this rule there have been twenty-two arrests and convictions and these have had a very wholesome effect in preventing further trespass. In March, 1918, on information supplied to the police by Ranger Cartwright, 13 chauffeurs were arrested for going to Manana and killing rabbits without a permit and for robbing nests of eggs and molesting the birds which breed there. All pleaded guilty and were given a thirteen months' suspended sentence. In June of the same year, nine other people from Honolulu made an unauthorized visit to the same island and committed similar depredations. They were arrested by the police on the following day and upon appearance in the police court pleaded guilty and each was given a suspended sentence of 13 months.

FOREST FENCING.

The work of protecting forest reserve boundaries by fencing has progressed during the past two years as rapidly as attention could be given it. In most cases a personal examination of the boundary to determine just where the fence should be constructed and the amount of material required is necessary, and where pri-

vate land is involved negotiations must be made with the owner for cooperative fencing. Owing to the nature of the land short stretches of fence across a valley or over a ridge will protect large areas further back on the mountains and so far as possible the lines of new forest reserve boundaries have been laid out so that natural barriers, impassable to stock, are taken advantage of. In addition to the construction of new fences, attention has been given as well to the repairing of existing fences, for in this manner stock can effectively be kept out of a forest at comparatively small expense and a fence is not worth much unless it is stockproof.

The anthrax outbreaks which required my personal attention for several months during 1917 interfered somewhat with the fencing program. Many of the boundaries to be fenced are situated in out of the way places where it is hard to transport the posts and wire and where labor is scarce and hard to obtain, but it was found possible through the efforts of this Division and cooperation with private owners and the Land Office to construct during the biennial period 14.42 miles of new fence and repair 4.21 miles of existing fences on forest reserve boundaries, making a total of 18.63 miles of boundary adequately protected by the necessary stockproof fences.

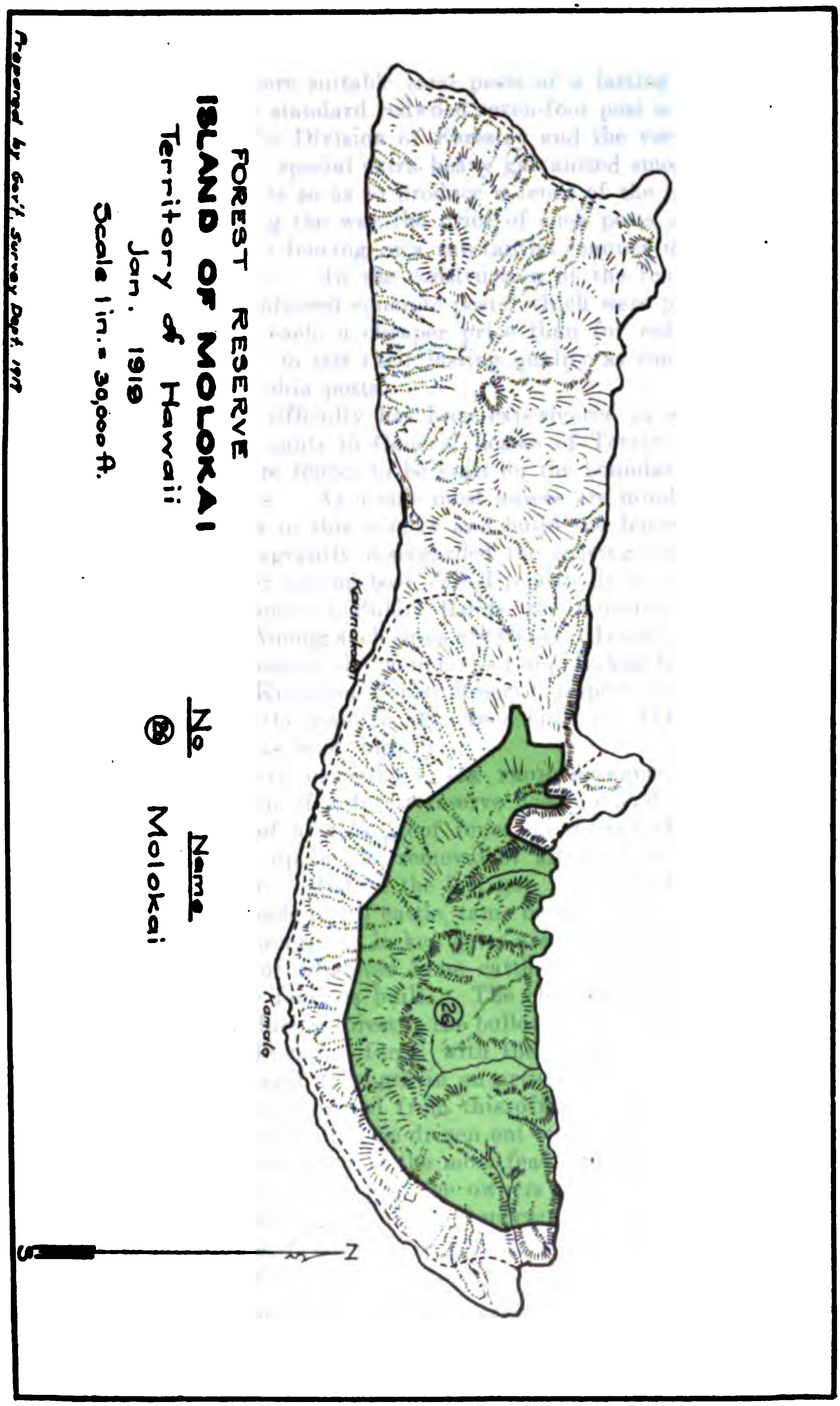
The fencing work in detail during the past two years was as follows:

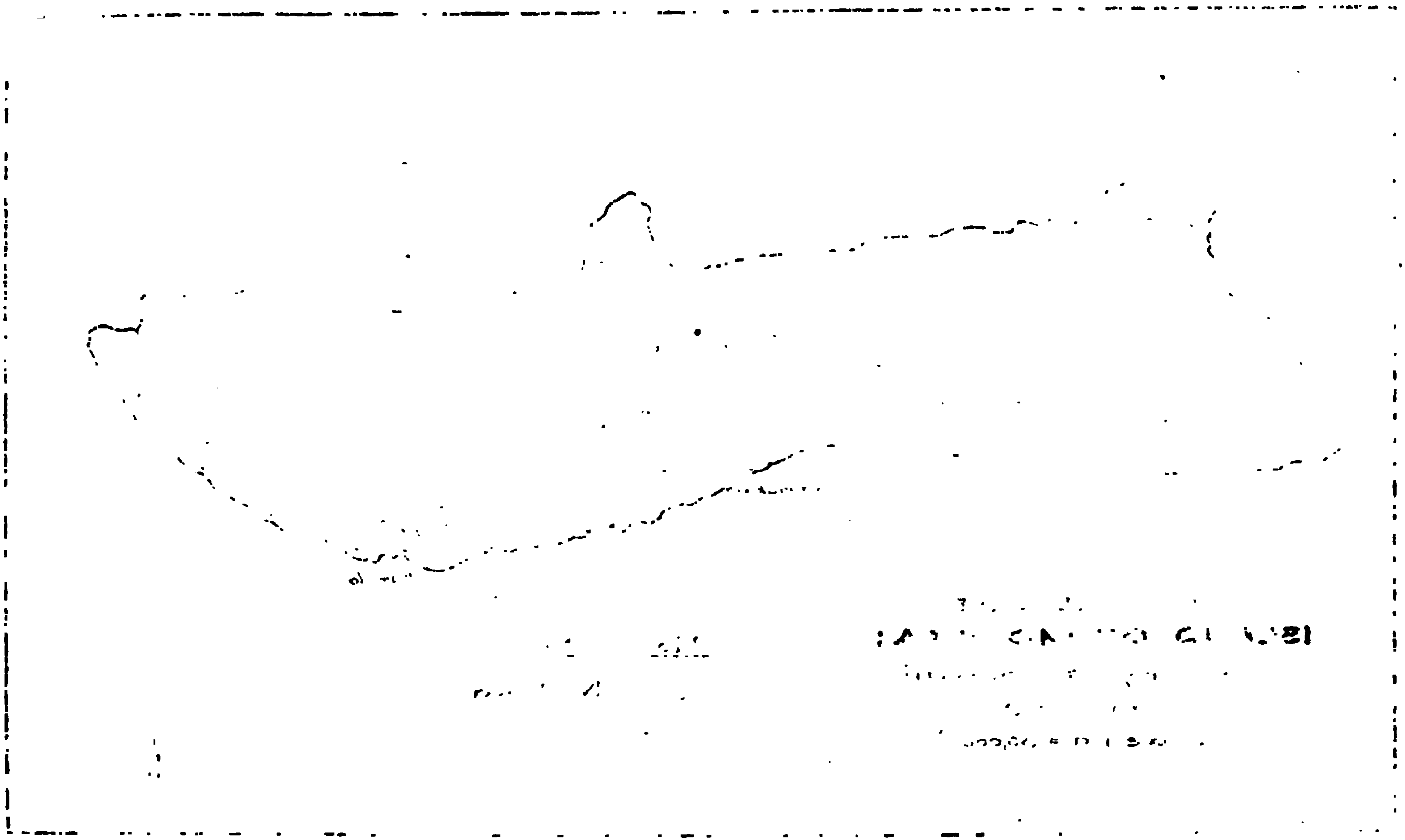
FENCES CONSTRUCTED, 1917-1918.

Date Completed.	Island.	Reserve.	Location	Length (miles)
May, 1917	Oahu	Honolulu Watershed	Makiki	.08
Sept., 1917	Hawaii	Olaa Forest Park	Olaa	.48
Nov., 1917	Oahu	Nanakuli	Nanakuli	1.35
Dec., 1917	Hawaii	Hilo	Laupahoehoe	2.78
May, 1918	Hawaii	Hilo	Piha	3.42
July, 1918	Oahu	Waianae-kai	Waianae	.22
Aug., 1918	Maui	Makawao	Makawao	.89
Sept., 1918	Oahu	Waiahole	Waiahole	.59
Sept., 1918	Oahu	Hauula	Hauula	1.05
Dec., 1918	Hawaii	Olaa Forest Park	Glenwood	3.56
			Total	14.42

FENCES REPAIRED, 1917-1918.

Date Completed.	Island.	Reserve.	Location	Length (miles)
April, 1917	Oahu	Honolulu Watershed	Nuuanu	.37
June, 1918	Oahu	Pupukea	Pupukea	1.19
Aug., 1918	Maui	Makawao	Makawao	.53
Nov., 1918	Maui	Makawao	Olinda	1.31
Dec., 1918	Oahu	Waiahole	Waiahole	.81
			Total	4.21


FOREST RESERVE
ISLAND OF MOLOKAI
Territory of Hawaii
Jan. 1918
Scale 1 in. = 30,000 ft.
No
Name
㉖
Molokai
Kaunakakai
Kamalo
㉖
N
Prepared by Gov't. Survey Dept. 1917



As a rule, where suitable local posts of a lasting nature are not obtainable, the standard redwood seven-foot post is used in all fencing work of the Division of Forestry and the very best wire obtainable, a No. 6 special extra heavy galvanized smooth wire, is strung to these posts so as to produce a fence of the most lasting character. During the war the price of such posts and of wire has doubled so that fencing in a substantial manner now costs at least $500 per mile. In the construction of the fence at Glenwood, Hawaii, reenforced concrete posts, which were picked up in Hilo for 60 cents each, a cheaper price than for redwood posts, were used in order to test their lasting quality as compared with the locally grown ohia posts.

Considerable difficulty has been experienced in securing the fulfillment of covenants in General Leases of Territorial grazing lands which require fences to be built on the boundaries of adjacent forest reserves. As a rule most lessees are mindful of their solemn obligations in this respect and build the fences promptly, but a few have flagrantly disregarded the fencing clause and, in spite of the matter having been called repeatedly to the attention of the Commissioner of Public Lands, the required fences still remain unbilt. Among such cases are General Leases No. 730 and 837, in which fences on the boundary of the Makua-Keaau Forest Reserve and the Kuliouou Forest Reserve, respectively, on Oahu, were required by the lease to have been built in 1914, but as yet not a post hole has been dug.

REMOVAL OF WILD STOCK FROM RESERVES.

The protection of a forest reserve does not end, however, in the construction of a stock-proof fence on its boundaries. This must be followed up by the removal of all stock which still remain in the forest. Before the last gap in a boundary fence is built a drive is made of all cattle, tame or wild, which can be removed in this manner, and locked gates are left at strategic points for the removal of whatever tame cattle may inadvertently get through after the fence is built. The chief enemy of our indigenous water-producing forest is the bullock and the damage which he does to our Hawaiian forest with the destructive results that follow were discussed at length in an article entitled "Forestry as Applied in Hawaii"* issued from this office last spring. Tame cattle as a rule can readily be driven out or roped and led out but when they have become wild the most feasible method of removal is in gunny sacks. As a rule the owners of branded wild cattle have been given an opportunity to remove their stock from forest reserve lands by a specified date, after which the Division has felt free to remove them in the manner deemed most advisable. In this way a considerable amount of wild stock has been eliminated from forest reserves. Where the owner of branded wild cattle is unknown, or cannot be located, more difficulty may be encountered and legislation to authorize the killing of such cattle, without compensation, but after published notice, is desirable.

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*The Hawaiian Forester and Agriculturist, Vol. XV, No. 5, May, 1918.

Since the hunting of wild animals on a forest reserve, except as authorized by permit from the Superintendent of Forestry, by Rule II constitutes trespass punishable by a fine, permits have readily been issued to responsible parties to shoot cattle, when the way is clear, and pigs and goats in the reserves on the several islands. Complete returns on the number of wild animals killed in this manner are not obtainable but from the reports which have reached this office through the rangers and otherwise, it is certain that during the past two years at least 129 wild cattle, 397 wild pigs and 141 wild goats (exclusive of Kahoolawe) have been shot or killed on or removed from government lands in forest reserves on Kauai, Oahu, and Hawaii. A condition is included in each permit requiring that as full use as possible be made of the meat of such animals, and in this manner the forest reserves have helped out considerably in the food supply.

FOREST FIRES.

During the past two years, in spite of some unfavorable weather conditions, we were fortunate in having no serious forest fires which did any extensive damage, and only a few grass fires, the dates and localities of which were as follows:

June 25, 1917.—Ewa Forest Reserve, Oahu. A fire which started from smoking out a bee tree spread at 11 a.m. on the military reservation of Waianae-uka on the South Fork of the Kaukonahua River and burned over about 50 acres of grass land and ferns with a few clumps of trees before it was gotten under control by nightfall through the efforts of two troops of the Fourth Cavalry and 90 prisoners of war.

August 19, 1917.—Maili Ridge, Oahu. A small grass fire started on the Leilehua plateau, but was extinguished the same day by U. S. troops.

August 28, 1917.—Piihonua, near Hilo, Hawaii. A fire escaped from a Hawaiian burning brush and burned over about 50 acres of open and scrub forest land. Laborers from nearby plantations under the direction of Fire Warden John A. Scott succeeded in getting the fire under control after a few days' work.

September 16, 1917.—Waikapu Valley, Maui. A fire burned over 10 acres of waste land covered with pili grass and lantana, but was extinguished in a few hours.

Plate 3.

Popola, One of the Small Bird Islands off Oahu Protected by Rule IV.

November 9, 1918.—Ewa Forest Reserve, Oahu. A grass and brush fire occurred from causes unknown on the same area on the military reservation as the fire of June 25, 1917. About 25 acres were burned over before it was extinguished in two hours by a troop of cavalry assisted by a shower of rain.

During the dry period of 1917 new cloth fire warning notices were printed and distributed to the District Fire Wardens, who posted them at conspicuous points where fires were apt to occur.

In August, 1917, the menace of homesteaders' clearing fires and the dry condition of the woods at Laupahoehoe, Hawaii, made it advisable to appoint Mr. H. S. Rickard as Assistant Fire Warden and he rendered valuable services in preventing many small forest fires in this region. A number of new Fire Wardens were appointed throughout the Territory to take the place of those who had either died, resigned, or moved away from their districts.

A revised list of District Fire Wardens, together with the District Foresters, who look out for the interests of forestry in general, is presented at the end of this report.

FOREST EXTENSION.

The official setting apart of forest reserves, the fencing of their boundaries where necessary, and the elimination of stock must be followed up with the reestablishment of the forest cover by artificial means wherever it has been so badly depleted that it will not come back naturally. This is accomplished by planting trees. In this work the native koa and other indigenous trees have largely been used, but attempts have been made as well to obtain new species which will be suitable for covering our watersheds.

TREE INTRODUCTION.

We must naturally turn to all parts of the tropical world for new species, and a variety of new trees have been introduced by the Division during the past two years not only to determine which are suitable as watershed cover to supplement our native forest but which will produce valuable timber on areas where water conservation is not a factor. In this work of tree introduction Consulting Botanist Mr. J. F. Rock has been of material assistance. In April, 1917, 37 trees of 20 different species of trees which he brought from the Philippines were planted out on Tantalus in order that they might serve as a future source of seed for distribution throughout the Territory. These are important timber trees of the Philippine Islands which are profuse seeders and which probably will be suitable for watershed protection. They were permanently staked out and tagged so as to retain their identity. The

Consulting Botanist also supplied this Division with a quantity of seed of the Sau Tree, *Albizzia moluccana* from British North Borneo. This is a very rapidly growing tree which is already showing up very well with us.

Experiments with the growing of the Benguet pine, *Pinus insularis*, which we have raised from seed sent to us by the Director of Forestry at Manila, P.I., have proved that it will not grow to any size at our lower levels, but does very well at elevations of 6,000 feet on Hawaii. The seed of the Molave, *Vitex parviflora* which he has also sent have germinated well, and show good promise of succeeding here.

The Australian red cedars, *Cedrela australis*, introduced in 1916 and distributed to 22 different places in the islands, are doing remarkably well and in some localities have grown at the rapid rate of 11 feet in 15 months.

In August 1917, 39 different species of eucalypts, acacias, and other Australian trees raised from seed secured by Mrs. C. C. Kennedy and kindly presented to this Division were planted out on the Manoa Ranger Station to test their adaptability to the region.

During the same month two boxes of New Zealand trees were received from Hon. E. Mitchelson of Auckland and a part were set out on the Manoa Ranger Station. Among these are the kauri pine, rimu or red pine, *Dacrydium cupressinum*, and other important trees of New Zealand.

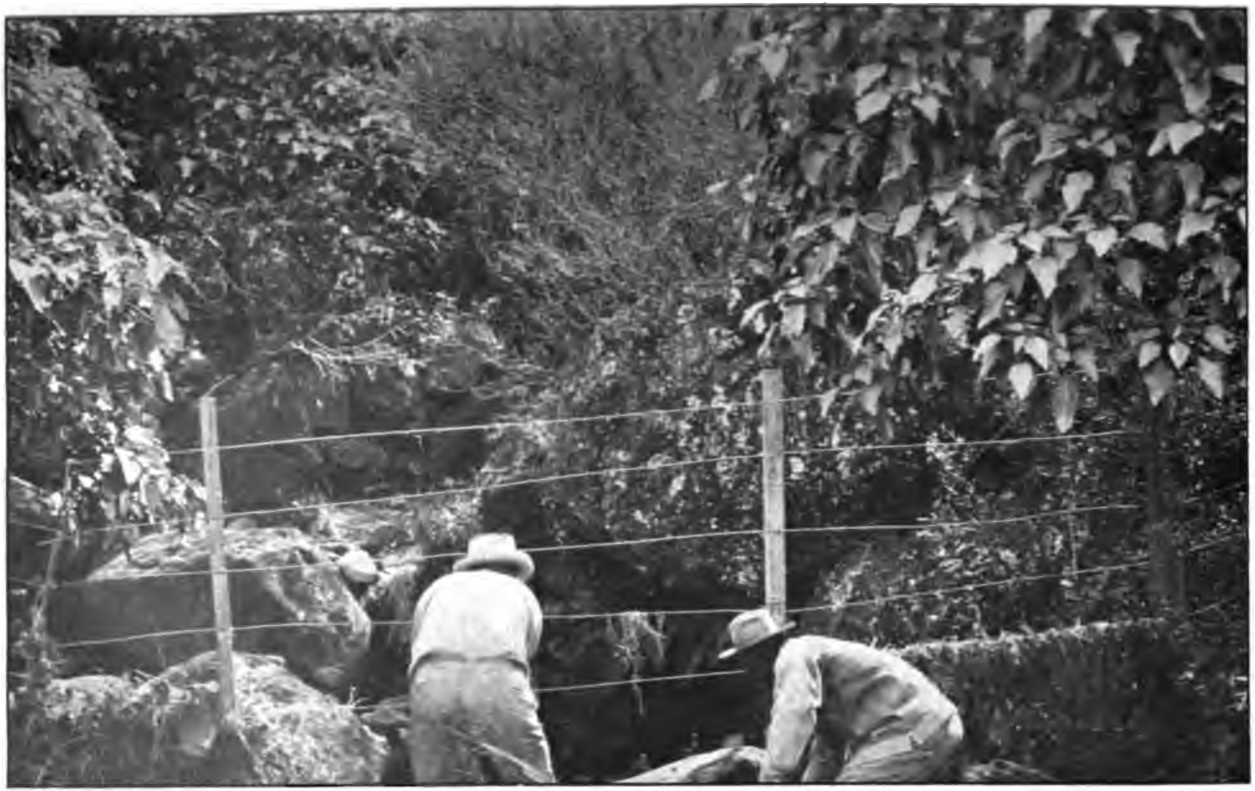
From trees growing in Honolulu we have obtained seed of the gum arabic, *Acacia arabica* and khair, *Acacia catechu*, and have raised young trees for distribution. These are two valuable Indian trees which are suitable for planting in the drier parts of these islands. Seedlings of the logwood have been similarly handled.

A supply of seed of the karaka tree, *Corynocarpus laevigata* was secured from the 1918 crop at Halemanu, Kauai, and distributed to forest rangers and inhabitants of the higher elevations on Maui and Hawaii for planting. Several pounds were also donated to the H. S. P. A. for use in their new forestry operations.

TREE PROPAGATION AND DISTRIBUTION.

The nurseries for the propagation and distribution of trees have continued to be maintained at Honolulu, Homestead, Kauai, and Hilo, Hawaii, and have done good service in supplying homesteaders, agriculturists, inhabitants of army posts, ranchers, and plantations throughout the Territory with forest, shade and ornamental trees. The total number of trees so distributed fell about a quarter of a million short of the number sent out during the previous two years but amounted to 651,411 trees. Shortage of labor for tree planting operations partly accounted for this de-

Plate 4.



Repairing Forest Reserve Boundary Fence at Lualualei, Oahu.

crease. Further details of this work are given in the report of the Forest Nurseryman.

ARBOR DAY.

Arbor Day as usual was celebrated in 1917 on November 16 and in 1918 on November 22. This is participated in mostly by school children whom we have attempted to assist in the beautification of their school grounds not only by furnishing them with trees for planting free of cost but also with advice as to their care and protection.

The numbers of trees distributed from the government nurseries for planting on Arbor Day during the last two years were as follows:

Nurseries	1917	1918	Total
Government Nursery, Honolulu	10,490	10,500	20,990
Sub-Nursery, Homestead, Kauai	1,287	1,125	2,412
Sub-nursery, Hilo, Hawaii	334	339	673
Total	12,111	11,964	24,075

This distribution is about 5,000 trees less each year than the average annual tree distribution during the past twelve years.

NEW FOREST NURSERY.

During July 1918, as a step in the extension of tree planting work on the forest reserves, a new nursery was established in the Lualualei Forest Reserve on the west slope of the Waianae Mountains, Oahu, just below Kolekole Pass. A small house for the accommodation of laborers was constructed and water was piped to the house and nursery terraces from the nearby perennial stream. Most of the seedlings are started in the Makiki Nursery and shipped down in seed boxes to this new nursery where they are transplanted and held until of sufficient size for planting out. The planting gang of Hawaiian laborers which in May 1918 had completed the reforestation of all open government forest reserve lands in Manoa Valley was shifted to this new locality where the forest cover should be reestablished because of the benefit which it will exert on the valuable springs and small streams in this comparatively dry region. This site was also selected because of the opportunity which it presents for testing out the trees which are best suited to the drier situations in these islands and for obtaining knowledge and experience along this line which at present are lacking.

A similar expansion of reforestation work is desirable at other places in the islands and it is hoped that sufficient funds will be available to permit the establishment of new nurseries with their accompaniment of tree planters on the Kula Forest Reserve, Maui, the Mokuleia Reserve, Oahu, and at Piihonua on the Hilo Watershed, Hawaii.

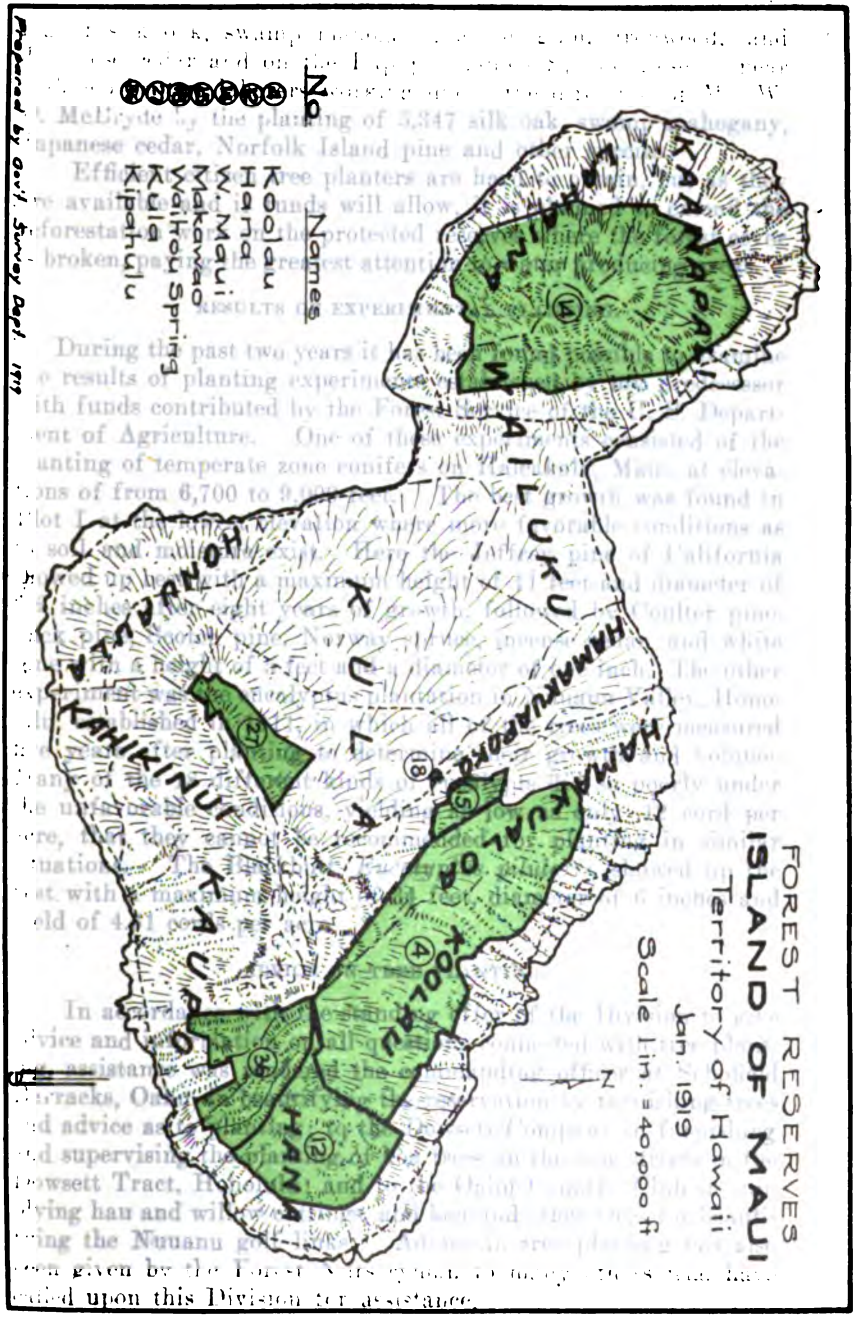
TREE PLANTING ON FOREST RESERVES.

The tree planting work done by the Division of Forestry during the past two years has been confined almost wholly to watershed areas and particularly to the water-producing region back of Honolulu, for it is only from a completely forested watershed that the best results in the way of an even and continuous flow of water can be obtained. The operations of the Division have extended over five different regions and a total of 44,444 trees have been planted and cared for on forest reserves at Makiki and Tantalus, Manoa, and Lualualei on Oahu and at the Papapaholahola Spring and Kamalomaloo on Kauai. In this planting, in addition to the miscellaneous species listed below, a total of 21,138 koa trees were set out. This native tree is used in the belief that it is quite suited to planting on situations where there is a well drained soil and that it forms a good cover since it allows native shrubs and ferns to come up in its shade. The koa responds readily to nursery treatment and the only difficulty which we have had is the inability to secure seed in large quantities because of an insect which riddles the pods before the seed is even ripe.

On the Honolulu Watershed Forest Reserve, Oahu, the reforestation of the open places in the Makiki Valleys, begun in 1913, was continued by the planting out of 8,796 koa on the slopes and 3,304 trees of various species at the lower ends of the valley bottoms. Among the latter were 1,484 mahogany and 686 yellow poinciana trees which were planted 8 by 8 feet apart in December, 1917, and May, 1918, respectively, to test their growth under close planting conditions. The koa trees which were first planted on Sugar Loaf are now five years old and constitute a healthy forest with a complete crown canopy. On this same reserve all of the open government lands in Manoa Valley were reforested in the sixteen months ended May, 1918. On approximately 63 acres there were set out 8,516 koa trees and 5,011 trees of other species among which were Australian tea trees, papala kepau, African tulip, banyan, Australian red cedar, sau tree, Japanese cedar, silk oak, Cook pine and Benguet pine.

On the Lualualei Forest Reserve, Oahu, the planting which began in July, 1918, included a total of 5,304 trees among which were 3,826 koa and the following dry region trees: wiliwili, gum arabic, black locust, yellow poinciana, kassod and logwood. On a part of the Pupukea Forest Reserve, Oahu, 2,934 trees of various species were set out under contract in December, 1918, on water Reserve A. by Libby, McNeill & Libby on land which had formerly been cultivated in pineapples.

On Kauai, the planting work was continued on the Kealia Reserve by Ranger Lovell by the setting out of 5,232 trees consist-


FOREST RESERVES
ISLAND OF MAUI
Territory of Hawaii
Jan. 1919
Scale 1 in. = 40,000 ft
N
No Names
④ Koolau
⑫ Hana
⑭ W. Maui
⑮ Makawao
⑱ Waikou Spring
㉗ Kula
㉞ Kipahulu
Prepared by Gov't. Survey Dept. 1919
KAANAPALI
LAHAINA
WAILUKU
HAMAKUAPOKO
HAMAKUALOA
KOOLAU
HANA
KAUPO
KAHIKINUI
HONUAULA
KULA
④
⑫
⑭
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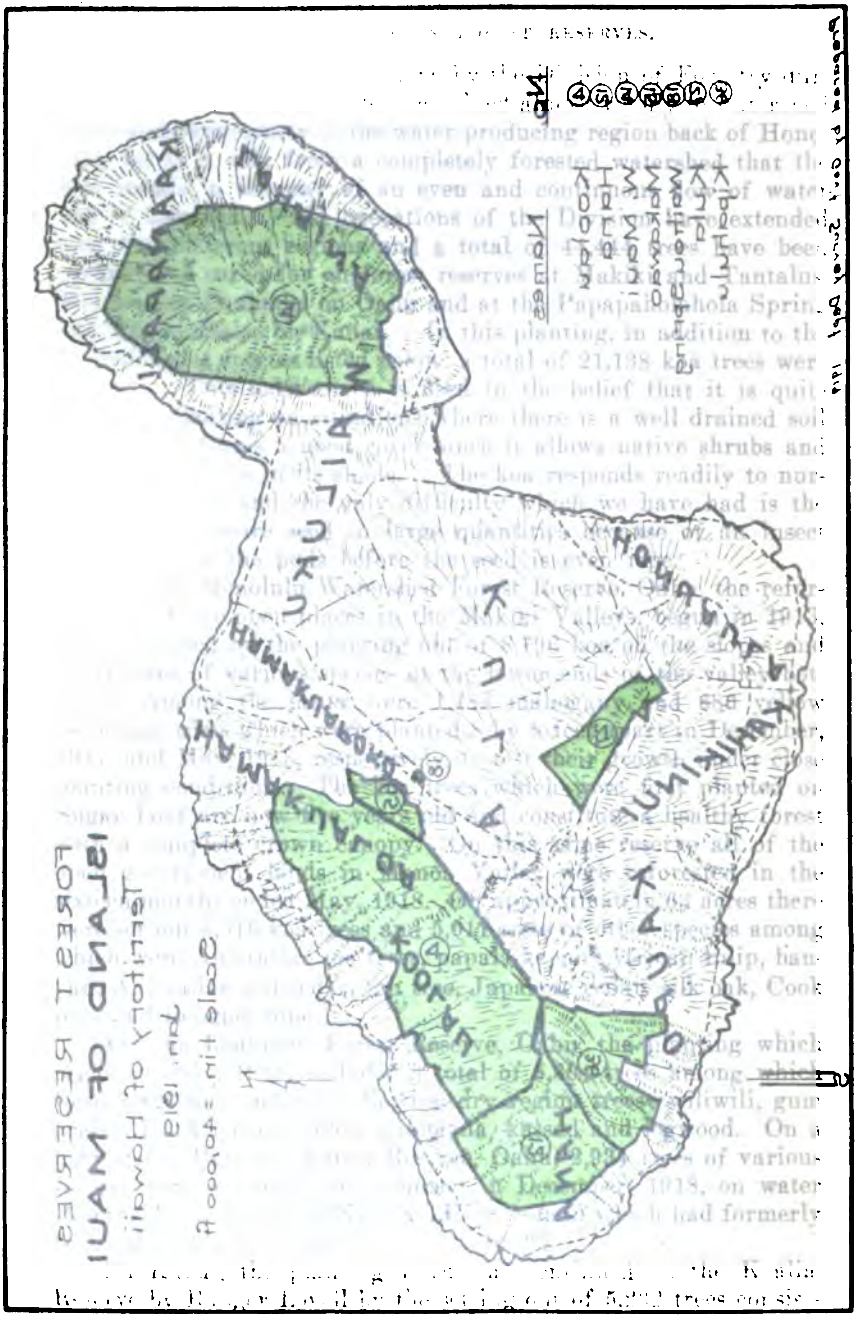

FOREST RESERVES
ISLAND OF MAUI
Territory of Hawaii
Jan. 1919
Scale 1 in = 40,000 ft
Names
Koolau
Hana
W. Maui
Makawao
Waihou Spring
Kula
Kipahulu
N
KAANAPALI
WAILUKU
HAMAKUAPOKO
HAMAKUALOA
KOOLAU
HANA
KULA
HONUAULA
KAHIKINUI
KAUPO

ing of silk oak, swamp mahogany, lemon gum, ironwood, and Japanese cedar and on the Papapaholahola Spring Reserve near Kalaheo by two laborers working under the direction of Mr. W. D. McBryde by the planting of 5,347 silk oak, swamp mahogany, Japanese cedar, Norfolk Island pine and other species.

Efficient citizen tree planters are hard to obtain, but as they are available and if funds will allow, it is planned to extend the reforestation work on the protected reserves where the forest cover is broken, paying the greatest attention to water producing areas.

RESULTS OF EXPERIMENTAL PLANTING.

During the past two years it has been found possible to examine the results of planting experiments established by my predecessor with funds contributed by the Forest Service of the U. S. Department of Agriculture. One of these experiments consisted of the planting of temperate zone conifers on Haleakala, Maui, at elevations of from 6,700 to 9,000 feet. The best growth was found in Plot I at the lowest elevation where more favorable conditions as to soil and moisture exist. Here the Jeffrey pine of California showed up best with a maximum height of 11 feet and diameter of 3½ inches after eight years of growth, followed by Coulter pine, Jack pine, Scotch pine, Norway spruce, incense cedar, and white pine with a height of 5 feet and a diameter of one inch. The other experiment was the eucalyptus plantation in Nuuanu Valley, Honolulu, established in 1911, in which all of the trees were measured five years after planting to determine their growth and volume. Many of the 18 different kinds of eucalypts did so poorly under the unfavorable conditions, yielding as low as only .12 cord per acre, that they cannot be recommended for planting in similar situations. The Blackbutt, *Eucalyptus pilularis*, showed up the best with a maximum height of 34 feet, diameter of 6 inches and yield of 4.51 cords per acre.

ADVICE ON TREE PLANTING.

In accordance with the standing offer of the Division to give advice and information on all questions connected with tree planting, assistance was rendered the commanding officer at Schofield Barracks, Oahu, in beautifying the reservation by furnishing trees and advice as to planting; to the Dowsett Company in furnishing and supervising the planting of koa trees on the new streets in the Dowsett Tract, Honolulu; and to the Oahu Country Club in supplying hau and willow cuttings, and koa and other trees for beautifying the Nuuanu golf links. Advice in tree planting has also been given by the Forest Nurseryman to many others who have called upon this Division for assistance.

TREE PLANTING ON PRIVATE LANDS.

In order to keep track of the general progress of forestry in the Territory reply post cards are sent out each year to all tree planters with the request that they return the number and species of trees planted and the purpose of planting. These figures, while not complete, because all tree planters cannot be reached, are analyzed and the results published every two years. For the biennial period just ended the total number of trees planted, as shown in the list which follows, was 1,632,598. This is only 171,130 trees short of the number planted in 1915 and 1916.

NUMBER OF TREES PLANTED IN THE TERRITORY OF HAWAII in 1917 and 1918.

KAUAI.

	1917	1918	Total
Gay and Robinson	1,500	3,205	4,705
Grove Farm Plantation	20,000	21,500	41,500
Hawaiian Sugar Co.	40,000	20,000	60,000
Isenberg, Rev. Hans	50		50
Kekaha Sugar Co.	505		505
Kilauea Sugar Plantation Co.	11,250	5,500	16,750
Knudsen Bros.	6,300	40,200	46,500
Lihue Ranch	4,278		4,278
Makee Sugar Co.	10,543	8,250	18,793
McBryde Sugar Co.	9,459	4,593	14,052
Territory of Hawaii	6,784	3,795	10,579
	110,669	107,043	217,712

OAHU.

	1917	1918	Total
Cooke, Mrs. C. M.	300	1,230	1,530
Dowsett Company	381		381
Ewa Plantation Co.		247	247
Hawaiian Pineapple Co.	4,000	9,000	13,000
Hawaii Preserving Co.	6,000	3,000	9,000
Honolulu Plantation Co.	20,110		20,110
Judd, Mrs. A. H. B.	200		200
Kahuku Plantation Co.		5,000	5,000
Kemoo Farm	100		100
Koolau Agricultural Co.	500		500
Kunia Development Co.	500		500
Laie Plantation	1,154	300	1,454
Marconi Wireless Tel. Co.	600		600
Sandwich Islands Honey Co.	17,000	20,000	37,000
Territory of Hawaii	18,065	15,800	33,865
United States Army	5,500	6,994	12,494
Wahiawa Water Co.	15,200	1,000	16,200
Waialua Agricultural Co.	70,801	78,712	149,513
	160,411	141,283	301,694

	1917	1918	Total
MOLOKAI.			
Baldwin Home	50		50
LANAI.			
Lanai Company	1,912	406	2,318
MAUI.			
Baldwin, Mrs. H. A.	1,600	650	2,250
East Maui Irrigation Co.	200		200
Grove Ranch	1,000		1,000
Haleakala Ranch	915	9,734	10,649
Hawaiian Comm. & Sugar Co.	1,400	1,000	2,400
Honolua Ranch	12,050	24,000	36,050
Krauss, Mr. F. G.	423	73	496
Maui Agricultural Co.	425,000	400,950	825,950
Pioneer Mill Co.	5,060	8,000	13,060
Wailuku Sugar Co.	10,700	20,923	31,623
	458,348	465,330	923,678
HAWAII.			
Gamalielson, Mr. J. E.	52		52
Greenwell, Mr. F. R.	1,000		1,000
Hakalau Plantation Co.	542		542
Hamakua Mill Co.	32,260	15,000	47,260
Hawaiian Agricultural Co.	9,591	9,185	18,776
Hawaii Consolidated R. R.	100		100
Hawi Mill and Plantation Co.	5,875	1,660	7,535
Homesteaders		6,188	6,188
Honokaa Sugar Co.	10,000		10,000
Hutchinson Sugar Plantation Co.		740	740
Kaiwiki Sugar Co.	200		200
Kohala Sugar Co.	12,000	5,000	17,000
Niulii Mill and Plantation	1,200	3,000	4,200
Onomea Sugar Co.		500	500
Paauhau Sugar Plantation Co.	2,000	8,000	10,000
Pacific Sugar Mill	10,000		10,000
Parker Ranch	39,689	11,710	51,399
Puakea Plantation Co.	500	1,000	1,500
Vieira, Mr. J. S.	44		44
Waiakea Mill Co.	110		110
	125,163	61,983	187,146
Total for all islands	856,553	776,045	1,632,598

The leading species planted and the purpose of planting are given in the following table:

NUMBER OF TREES PLANTED IN THE TERRITORY OF HAWAII IN 1917 AND 1918 BY SPECIES AND PURPOSE OF PLANTING.

Purpose of Planting.

1917

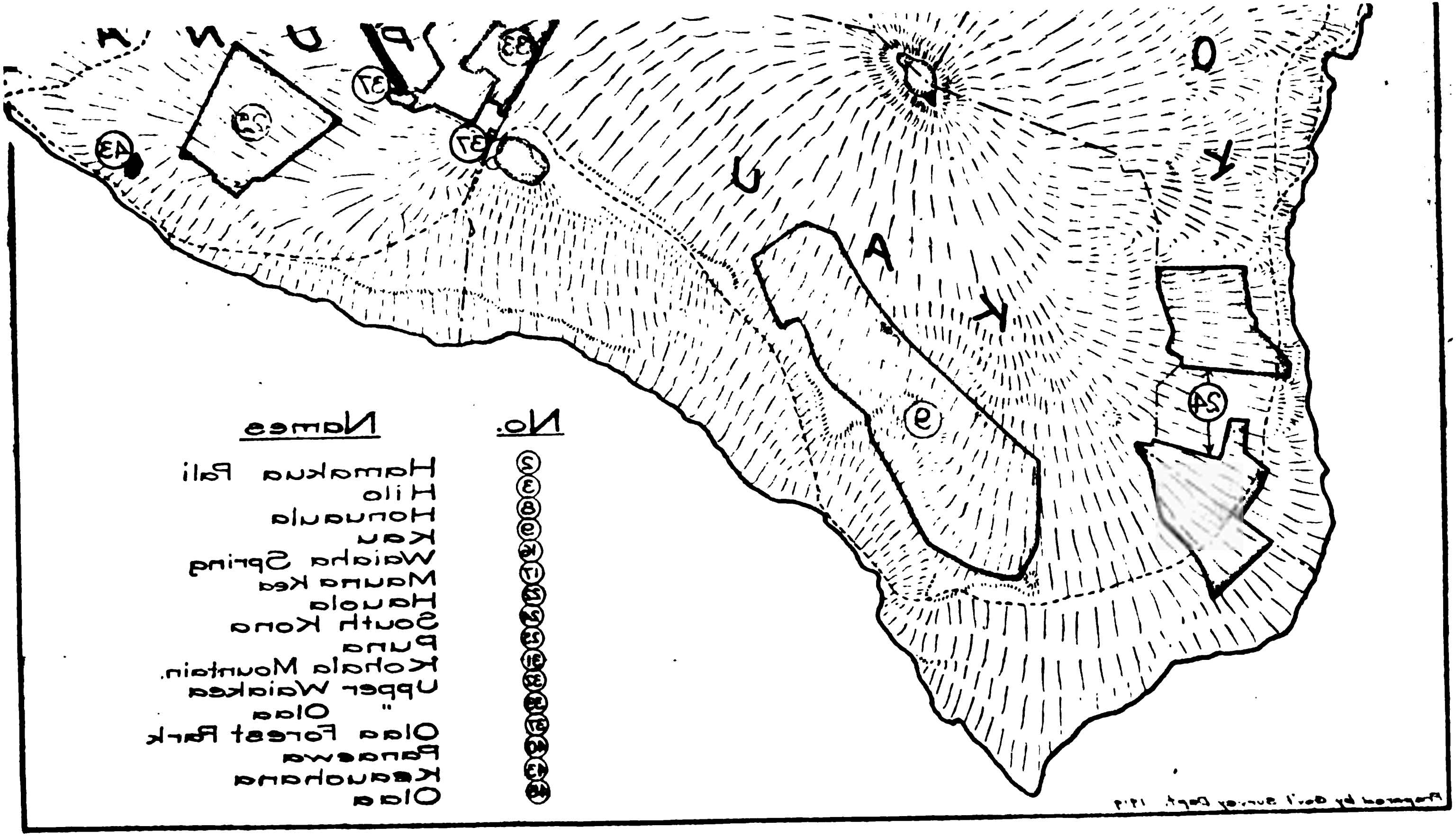
Species	Cover	Fuel	Wind-break	Ornament	Timber	Total
Swamp mahogany	385,743	79,519	8,081	25,600	900	499,843
Ironwood	....	60,604	53,900	20,520	....	135,024
Eucalptus spp.	....	26,116	44,604	....	15,000	85,720
Blue gum	....	42,000	3,000	450	2,500	47,950
Algaroba	....	20,590	....	....	....	20,590
Other spp.	2,547	....	60	7,514	5,557	15,678
Lemon gum	15,000	172	....	....	....	15,172
Silk oak	4,833	9,894	....	....	....	14,727
Koa	12,656	....	....	272	....	12,028
Japanese cedar	....	....	....	....	8,921	8,921
Totals	420,779	238,895	109,645	54,356	32,878	856,553

1918

Species	Cover	Fuel	Wind-break	Ornament	Timber	Total
Swamp mahogany	285,837	23,172	17,895	16,000	....	342,904
Blue gum	149,358	9,000	....	....	....	158,358
Ironwood	1,313	73,821	51,455	10,000	....	136,589
Red gum	13,800	38,515	18,794	....	....	71,109
Other spp.	6,676	....	1,000	24,327	....	32,003
Lemon gum	12,000	2,278	....	....	....	14,278
Koa	8,482	....	....	....	....	8,482
Eucalptus spp.	....	5,248	175	400	....	5,823
Silk oak	1,910	756	....	700	....	3,366
Algaroba	....	818	2,075	200	....	3,093
Japanese cedar	....	....	....	....	40	40
Totals	479,376	153,608	91,394	51,627	40	776,045

From the above it will be observed that the swamp mahogany, *Eucalyptus robusta,* is still the most popular tree for general planting and constitutes over 50 per cent of the total planted during the two years. The red gum, *Eucalyptus rostrata,* is said to withstand drought still better, however, and produces a more valuable wood, and is gaining in popularity with tree planters. Koa is also coming into greater prominence for planting on watersheds, the only difficulty being that good seed is hard to obtain on account of insect infestation.

During the previous two years, 44 per cent of the total number of trees planted were for the purpose of reestablishing a cover on watershed areas. That greater attention has lately been paid to reforestation for this purpose is evidenced by the fact that during the two years just ended the total number of trees planted on watershed areas constituted over 55 per cent of the total.


No.
Names
2 Hamakua Pali
3 Hilo
8 Honuaula
9 Kau
Waiaha Spring
17 Mauna Kea
Hauola
South Kona
Puna
Kohala Mountain.
Upper Waiakea
" Olaa
Olaa Forest Park
Panaewa
Keauohana
Olaa
9
24
37
33
43
K
A
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Prepared by Gov't Survey Dept. 1919

MISCELLANEOUS.

The other activities of the Division of Forestry have been given secondary consideration in view of the importance of the two main subjects described above. There is much investigative work of an important nature which should be undertaken and a considerable amount of desirable record work in the office which must be deferred until technical assistance is available or until time presents the opportunity.

COOPERATION WITH THE LAND OFFICE.

As during previous years, the Division of Forestry has continued to cooperate with the Commissioner of Public Lands in giving advice on technical forestry questions which come up in that office in connection with general leases and other matters and in reporting on the fulfillment of clauses concerning forestry in such leases. When a new lease of government grazing lands is made, fencing and other clauses requiring forest protection have been drafted for inclusion in the lease. Technical field assistance has also been rendered in prescribing and directing the thinning of algaroba trees under licenses issued by the Land Office which will increase the yield of honey, beans and wood.

During the fall of 1918, the Superintendent of Forestry accompanied the new Governor and the Commissioner of Public Lands on an official inspection of government lands on Kahoolawe, Hawaii, and Maui.

KAHOOLAWE.

Assistance was also given the Land Office in the preparation of clauses for inclusion in the new lease of the island of Kahoolawe which runs for 21 years from January 1, 1919. These clauses provide for the management of the island in such a manner that the goats will be exterminated during the first year and every encouragement will be given to the revegetation of the island by natural and artificial methods. As will be recalled, on April 20, 1918, after a public hearing, Kahoolawe was withdrawn from the forest reserve and returned to the jurisdiction of the Commissioner of Public Lands because under the old arrangement the complete extermination of the goats could not be accomplished, and the Board was not able by law to make a lease whereby sufficient inducements could be offered anyone to bring this about. Over 5,000 goats have been eradicated from the island during the eight years that it has been under the control of this Board and the algaroba has spread to such an extent that there is now a large annual crop of beans which should be utilized along with several thousand acres of good pili grass by restricted grazing. This the new lease allows, but only after the extermination of the goats, which must be accomplished during the first year. The whole purpose of the lease is to develop, conserve and improve the island rather than to exploit it.

KOKEE CAMPS.

A new departure for the Division was instituted during 1918, when at the expiration of a government lease, certain mountain meadow lands near the Kokee Stream and Halemanu on Kauai, within the Na Pali-Kona Forest Reserve, Kauai, at an elevation of 3,500 feet came under the jurisdiction of this Board. In response to requests from those who desired the privilege of camping out in this invigorating climate in the same manner that camping privileges are extended to many thousands on mainland National Forests, a total of 47 camping sites were surveyed out in the open areas along mountain streams and a form of permit which will safeguard the best interests of the forest and protect individual permittees was approved. These permits are for ten years and the annual charge for unimproved sites is based on the nominal rate of $10 per acre. The camp sites vary in size from .3 to 2.0 acres and are situated not far from the scenic beauties of Waimea Canyon, where the rainfall is not excessive and the nights are always cool. A good opportunity is presented here for those who desire a change from the lowlands in a cooler climate amidst pleasant surroundings. Kokee Camps are at present accessible over a passable automobile road which in all probability will be improved in the near future.

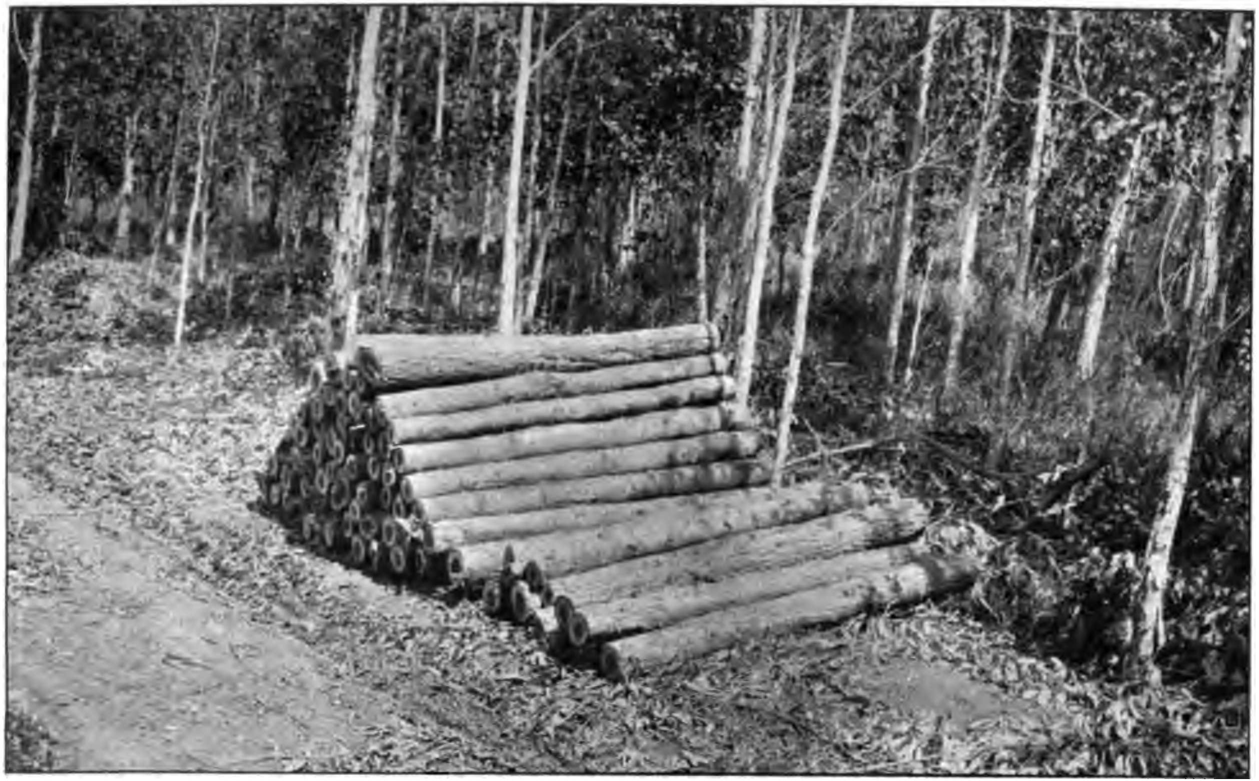
FIRST TERRITORIAL FAIR EXHIBIT.

Along with the other divisions of this Board, the Division of Forestry presented an exhibit at the First Territorial Fair, held at Kapiolani Park on June 10 to 15, 1918, which brought forth favorable comment from all who viewed it. In addition to the exhibits of young forest seedlings and transplants, native and introduced woods and bamboos, and maps showing forest reserves, a working erosion model was operated to show the beneficial effect of a forest cover on the runoff. By this model it was possible to bring home to the people in a very telling manner the lesson of the disastrous results of deforestation on watersheds and the valuable part which our native forest plays in the conservation of water and the importance of absolute forest protection in these islands.

PLANT PESTS.

Efforts have been made during the past two years to assist

Plate 5.



Durable Posts Cut from Eight Year Old Bloodwood Trees, ***Eucalyptus corymbosa*****, Grown in the Dry Land District, Waipio, Oahu**

in the eradication of plant pests by destroying them on our own grounds and sending out warnings against their spread elsewhere. One of these, *Caesalpinia bonduc,* is a rambling climber with very sharp, hook-like spines, which upon invasion takes complete possession of everything within its reach. It has been in the islands for many years but fortunately is confined to a few localities. One of these was in Hering Valley in Makiki, but by persistent efforts in not only cutting and burning up all the plants and destroying the roots but also by destroying young seedlings which came up later, we have at last been able to eliminate it.

Another weed which spreads extensively and at an alarming rate is the Spiny Pig Weed, *Amaranthus spinosus.* As its name denotes, it bears a pair of very sharp thorns at the base of the leaves. Cattle will not eat the plant and shun the localities where it occurs. Upon detecting its unusually rapid spread in Manoa Valley attention to it was called in the May, 1917, "Hawaiian Forester and Agriculturist," with the advice that wherever found it be rooted out and burned before the seeds are ripe.

A new introduction, which it is hoped will not become established here, by the persistent efforts which have already been made to eradicate it, is the Morning Glory, or Bindweed, *Convolvulus arvensis,* which was discovered last fall on Maui. A warning against it was published in the November, 1918, "Hawaiian Planters' Record," and upon investigation by Ranger Lindsay it was found to be confined to two small patches along the Kahului Railway in Paia. This leads one to believe that it came in with hay or some other feed stuff. It is a troublesome weed on cultivated fields in the Atlantic States and California, and it would be very unfortunate if it became established here.

Chance introductions such as this are apt to occur in spite of all precautions but by exerting our best efforts in their eradication upon discovery and by apprising the people of the necessity of doing likewise it is believed that a great deal can be accomplished to prevent their establishment in these islands where we already have our share of plant pests.

PUBLICATIONS.

The following have been published by the Division of Forestry during the past two years in addition to the monthly and annual reports and special articles which have appeared in "The Hawaiian Forester and Agriculturist," the official monthly magazine of the Board:

April 6, 1917. "Report of the Division of Forestry for the Biennial Period Ending December 31, 1916."
July 28, 1917. Rule IV, Division of Forestry.
August, 1917. Botanical Bulletin No. 4, "The Ohia Lehua Trees of Hawaii," by Joseph F. Rock, Consulting Botanist.
May, 1918. "Forestry as Applied in Hawaii," by C. S. Judd, Superintendent of Forestry. Reprint from "The Hawaiian Forester and Agriculturist," Vol. XV, No. 5.

SUMMARY.

In conclusion, it is a pleasure to report that progress has been made in the two main activities of the Division, forest protection and forest extension. The work of examining, surveying, and setting aside the main forest reserve system has been concluded and the reserves which are shown on the maps printed with this report, now include 814,926 acres, 68 per cent. of which is government land. On the four main islands seven forest rangers are on duty protecting and administering government forest reserve lands and they have had a hand in the construction and repairing of 18.63 miles of reserve boundary fences and the elimination of much wild stock during the biennial period. Tree planters are gradually reforesting open areas in the reserves mainly in regions where water for city and domestic use is required. For the continuation of these lines of work an adequate appropriation for the coming biennial period will be greatly appreciated and more particularly for a few additional forest rangers, for more extensive fencing, and for the establishment of new forest nurseries accompanied by tree planting.

Respectfully submitted,

C. S. JUDD,
Superintendent of Forestry and Chief
Fire Warden.

LIST OF DISTRICT FIRE WARDENS

CHIEF FIRE WARDEN.

C. S. JUDD, Superintendent of Forestry, ex-officio.

DEPUTY FIRE WARDEN AT LARGE.

DAVID HAUGHS, in and for the Territory of Hawaii.

DISTRICT FIRE WARDENS.

KAUAI.

A. MENEFOGLIO, in and for Wainiha Valley, District of Halelea.

W. F. SANBORN, in and for the District of Halelea, excepting Wainiha Valley.

L. D. LARSEN.

GEORGE HUDDY, Assistant District Fire Warden. In and for the District of Koolau, excepting the land of Anahola.

E. M. CHEATHAM, In and for the portion of the Districts of Koolau and Puna, extending from the land of Anahola to the land of Olohena, inclusive.

C. H. WILCOX, In and for that portion of the District of Puna, south of and including the land of Wailua.

FRANK A. ALEXANDER, In and for that portion of the District of Kona, extending from the Hanapepe Valley to the Puna District line.

B. D. BALDWIN, In and for that portion of the District of Kona lying between and including the Waimea, Poomau, and Kauaikinana Valleys on the west and the Hanapepe Valley on the east.

ERIC A. KNUDSEN, In and for the District of Na Pali and that portion of the District of Kona, lying to the west of Waimea, Poomau, and Kauaikinana Valleys.

OAHU.

F. S. LYMAN, JR., In and for that portion of the District of Koolauloa from the Waialua District line to and including the land of Kaunala.

ANDREW ADAMS, In and for that portion of the District of Koolauloa lying to the north and east of the land of Kaunala.

W. H. CLEGHORN, In and for that portion of the District of Koolaupoko, extending from the Koolauloa District line to the land of Heeia.

WM. HENRY, In and for that portion of the District of Koolaupoko, extending from and including the land of Heeia to the land of Kailua.

JOHN HERD, In and for that portion of the District of Koolaupoko, extending from and including the land of Kailua to Makapuu Point.

CHARLES H. BAILEY, In and for that portion of the District of Kona, extending from Makapuu Point to Palolo Valley.

JOSEPH K. KAPONO, In and for Palolo Valley, District of Kona.

C. MONTAGUE COOKE, In and for Manoa Valley, District of Kona.

W. M. GIFFARD, In and for that portion of the District of Kona lying between Pauoa and Manoa Valleys.

L. A. MOORE, In and for Nuuanu Valley, District of Honolulu.

WM. WEINRICH, In and for that portion of the District of Ewa lying to the West of the main government road.

JAMES GIBB, In and for that portion of the District of Ewa lying between the lands of Moanalua and Waiawa.

H. BLOOMFIELD BROWN, In and for that portion of the District of Ewa lying to the east of the main government road between the land of Waipio and the Kaukonahua Gulch.

A. A. WILSON, In and for that portion of the District of Waialua, lying between the Kaukonahua and Helemano Gulches.

GEORGE M. ROBERTSON, In and for that portion of the District of Waialua lying between the Helemano and Opaeula Gulches.

GEORGE WILSON, In and for that portion of the District of Waialua lying between the Opaeula Gulch and the Koolauloa District line.

F. MEYER, In and for that portion of the District of Waianae lying to the west of the Waianae Mountains.

MOLOKAI.

JAMES MUNRO, In and for that portion of the Island of Molokai lying to the west of Wailau Valley and the land of Mapulehu.

C. C. CONRADT, In and for that portion of the Island of Molokai including and lying to the east of Wailau Valley and the land of Mapulehu.

LANAI.

GEORGE C. MUNRO, In and for the Island of Lanai.

MAUI.

A. W. COLLINS, In and for the District of Lahaina.

DAVID T. FLEMING, In and for the District of Kaanapali.

C. E. S. BURNS, In and for the District of Wailuku.

F. F. BALDWIN, In and for the District of Hamakuapoko and the west half of the District of Hamakualoa.

W. F. POGUE, In and for the east half of the District of Hamakualoa and that portion of the District of Koolau lying to the west of Makapipi Gulch.

MARION CABRAL, In and for that portion of the District of Koolau lying to the east of Makapipi Gulch.

JOHN CHALMERS, In and for the District of Hana.

JOHN FASSOTH, In and for the District of Kipahulu.

L. VON TEMPSKY, In and for the Districts of Kula and Kaupo.

HAWAII.

G. C. WATT, In and for that portion of the north half of the District of Kohala extending from the land of Kaauhuhu. to the Hamakua District line.

SAM P. WOODS, In and for that portion of North Kohala extending from the northern boundary of the land of Kawaihae I. to and including the land of Kaauhuhu.

A. W. CARTER, In and for the District of South Kohala.

W. P. NAQUIN, In and for the western part of the District of Hamakua extending to the west from the boundary of the land of Paauhau to the boundary of the land of Kukaiau.

DONALD S. MACALISTER, In and for that portion of the District of Hamakua extending from and including the land of Kukaiau to the Hilo District line.

JOHN M. ROSS.

H. S. RICKARD, Assistant District Fire Warden, In and for that portion of the District of Hilo extending from the Hamakua District to the land of Makahanaloa.

JOHN T. MOIR, In and for that portion of the District of Hilo extending from and including the land of Makahanaloa to the land of Kikala.

JOHN A. SCOTT, In and for that portion of the District of Hilo extending from the Puna District line to and including the land of Kikala.

C. F. ECKART, In and for the District of Puna.

JAMES CAMPSIE, In and for that portion of the District of Kau extending from the Puna District line to and including the land of Punaluu.

GEORGE GIBB, In and for that portion of the District of Kau extending from the land of Punaluu to the Kona District line.

R. A. McWAYNE, In and for that portion of the District of Kona extending from the Kau District line to and including the land of Kaapuna.

T. C. WHITE, In and for that portion of the District of Kona extending from the land of Kaapuna to and including the land of Hookena.

L. P. LINCOLN, In and for that portion of the District of Kona extending from the land of Hookena to and including the land of Kaawaloa.

T. C. WHITE, In and for that portion of the District of Kona extending from the land of Kaawaloa to and including the land of Kahaluu.

JOHN A. MAGUIRE, In and for that portion of the District of Kona extending from the land of Kahaluu to the Kohala District line.

FOREST RANGERS.

Kauai.

W. V. HARDY.

HOSEA K. LOVELL, For the Island of Kauai.

Oahu.

DAVID KAPIHE, In and for Tantalus and Makiki and Pauoa Valleys.

E. H. HIPPLE, In and for Palolo, Manoa, and Nuuanu Valleys.

JOHN PILILAAU, In and for the Waianae District.

Maui.

JAMES LINDSAY, For the Island of Maui.

Hawaii.

A. J. W. MACKENZIE, For the Island of Hawaii.

HONORARY FOREST RANGERS.

W. H. SHIPMAN, In and for the District of Puna and Hilo, Hawaii.
BRUCE CARTWRIGHT, JR., For the enforcement of Rule IV, Division of Forestry, on Oahu.

DISTRICT FORESTERS.

Kauai.

Albert S. Wilcox, L. D. Larsen, C. H. Wilcox, Edward Broadbent, Rev. J. M. Lydgate, Walter D. McBryde, Eric A. Knudsen, B. D. Baldwin.

Oahu.

Andrew Adams, L. L. McCandless, John Herd, Paul R. Isenberg, W. W. Goodale.

Molokai.

James Munro, C. C. Conradt.

Lanai.

George C. Munro.

Maui.

A. W. Collins, F. F. Baldwin, W. F. Pogue, L. von Tempsky, Dr. J. H. Raymond, D. T. Fleming, John Fassoth.

Hawaii.

G. C. Watt, A. W. Carter, W. P. Naquin, John M. Ross, John A. Scott, George Gibb, W. R. Castle, James Campsie, John A. Maguire.

REPORT OF THE FOREST NURSERYMAN

Honolulu, Hawaii, December 31, 1918.

Superintendent of Forestry,
Honolulu, Hawaii.

Dear Sir: I respectfully submit the following report for the years 1917 and 1918:

COLLECTION AND EXCHANGE OF SEED.

We have had many applications from abroad during the past two years for seed of our exotic and indigenous plants. From Australia we received a large number of orders for algaroba seed, *Prosopis juliflora.* From other countries the demand was principally for flowering trees and shrubs. We have received in exchange seed such as different kinds of ficus, junipers, cypress, and a number of species of the pine family, etc.

TREES DISTRIBUTED FROM GOVERNMENT NURSERIES DURING 1917 AND 1918.

Oahu: 1917

Honolulu:

	Seedlings	Transplants	Pot Grown	Total
Sold	....	1,377	1,366	2,743
Gratis				
Arbor Day	....	....	10,490	10,490
Forest Reserves	6,000	5,000	1,495	12,495
Homesteaders	7,100	2,350	640	10,090
Military Posts	....	2,500	3,000	5,500
Parks	....	....	300	300
Schools	....	....	850	850
Street Planting	....	....	432	432
Miscellaneous	9,000	1,034	1,370	11,404
	22,100	12,261	19,943	54,304
Hawaii sub-nursery, including Arbor Day				7,568
Kauai sub-nursery, including Arbor Day				8,087
Plantation companies, etc.				283,550
				353,509

Oahu: 1918.

Honolulu:

	Seedlings	Transplants	Pot Grown	Total
Sold	....	830	1,795	2,625
Gratis				
Arbor Day	....	....	10,500	10,500
Homesteaders	3,000	2,803	712	6,515
Forest Reserves	7,700	2,050	286	10,036
Military Posts	....	5,390	1,604	6,994
Parks	....	....	55	55
Schools	....	250	1,266	1,516
Street and Road Planting	2,400	....	724	3,124
Miscellaneous	1,000	1,890	3,927	6,817
	14,100	13,213	20,869	48,182

Hawaii sub-nursery, including Arbor Day	6,188
Kauai sub-nursery, including Arbor Day	6,010
Plantation companies, etc.	237,522
	297,902

Total Tree Distribution, 1917 and 1918, 651,411.

Government Realizations.

1917.

Sale of Plants	$ 41.85
Rent of Office, Nursery Grounds	420.00
	$461.85

1918.

Sale of Plants	$ 45.55
Rent of Office, Nursery Grounds	420.00
Sale of aged horse	50.00
	$515.55

Preservation and Extension of Forestry and Forest Reserves.

1917.

Rent and Fees	$212.50
Sale of black sand	52.25
Sale of posts from Tantalus	2.25
Total	$267.00

1918.

Rent and Fees	$210.25
Sale of black sand	181.00
Total	$391.25

Government realizations are deposited with the Treasurer at the end of each month. Collections on account of Preservation and Extension of Forestry and Forest Reserves are deposited with the Treasurer at the end of each quarter, and go into the special fund.

PLANTATION COMPANIES AND OTHER CORPORATIONS.

The number of trees ordered by plantation companies and other corporations during 1918 was not so large as in some of the past years. The falling off, no doubt, was due to the scarcity of labor on most of the plantations.

The following is a list of trees distributed during the past two years:

	1917	1918	Total
Eucalyptus robusta	127,300	95,200	222,500
" citriodora	20,100	25,500	45,600
" globulus	1,550	42,700	44,250
" rostrata	15,000	34,000	49,000
" resinifera	3,000	10,000	13,000
" crebra	38,000	....	38,000
" rudis	....	10,000	10,000
" pilularis	5,050	....	5,050
Casuarina equisetifolia	51,000	18,200	69,200
" quadrivalvis	3,250	1,000	4,250
Grevillea robusta	10,000	....	10,000
Swietenia mahogani	1,000	....	1,000
Cryptomeria Japonica	5,000	....	5,000
Miscellaneous	3,300	922	4,222
Total	283,550	237,522	521,072

MAKIKI STATION.

The work at this station consisted principally of transplanting trees into boxes, pots and tin cans, mixing and sterilizing soil to be used for seed raising and transplanting at this station and at the Nursery on King Street.

A great deal of saw mill work is done at this station which consists of cutting up wood for seed and transplant boxes, laths for making crates for shipping plants, fence posts, etc.

HONOLULU WATERSHED.

During the year 1917, 6,054 koa, 300 kukui, and 1,484 mahogany trees were planted, and during 1918, 2,742 koa, and 686 yellow poinciana trees were planted in the Makiki Valleys on the Honolulu Watershed. Other work consisted in rooting out pests. The *Caesalpinia bonduc* is almost exterminated both in Hering and Opu Valleys.

For about three months during the summer of 1918 the men employed on the watershed were transferred to the Tantalus forest for the purpose of cutting away and pruning the trees along the road. This was done at the request of people who had occasion to use the road who complained about the very bad condition of the road through the forest. They complained that owing to the dense shade caused by the trees, the road never had a chance to dry up, consequently the soil got churned into mortar by the wagons and became so deep in parts that it was next to impossible to get over it with any kind of a vehicle. The work was certainly appreciated by the people using the road, and the good effect was plainly observed a few weeks after the work was done. Considerable work has been done on the trails running through the watershed. There are long stretches of trails that require to be kept open, not only for the convenience of those who may want to use them but as a protection during the summer months against fires.

NURSERY AND GROUNDS.

The propagation and distribution of plants has been carried on with the aid of one man with occasional help from two seed boys and the yard man during the busy season. On the grounds up to about eighteen months ago High Sheriff Jarrett provided us with two trusties to help in keeping the grounds in good condition. Owing to not having men whom he could trust to send us we have been deprived during the past eighteen months of that much needed help. After the prison help was withdrawn it became necessary to employ two extra men. The regular yardman being often required to do rough carpentry work, pipe fixing and assisting at the saw mill in Makiki, etc., left the ground during the great part of the time to be kept in order by two men.

The wooden curbing laid about twelve years ago along the walks is fast decaying, and has disappeared entirely from a number of places. New curbing ought to be laid so that the parking around the buildings and the part used by the public could be kept in a more presentable condition.

Respectfully submitted,

DAVID HAUGHS,
Forest Nurseryman.

REPORT OF THE CONSULTING BOTANIST

Honolulu, Hawaii, December 31, 1918.

The Board of Commissioners of
Agriculture and Forestry,
Honolulu, Hawaii.

Gentlemen: I beg to submit my report as Consulting Botanist for the biennial period ended December 31, 1918.

During the summer of 1917 the writer visited Southern California for the purpose of acquainting himself with the large nurseries existing in Santa Barbara. He collected seeds in the various gardens in Southern California, and purchased numerous plants from the nurseries in Santa Barbara. The plants purchased were nearly all ornamental not as yet cultivated in the Territory. Among them were quite a number of palms, and also vines of which the most noteworthy were *Bignonia Kerere,* one of the handsomest and largest flowering bignonia known to the writer, and *Vitis capensis,* a South African ornamental grape with very handsome foliage. They have been planted out on the College of Hawaii campus where they are thriving well. At about the same time quite a number of valuable plants were presented to the writer for the Territory by the Conservatories of the Golden Gate Park, San Francisco, California. Among them were several species of palms, Aroids, Pandanaceae, etc.

After his return to the islands he visited Hawaii with Commissioner Giffard and the Superintendent of the Golden Gate Park Conservatories for the purpose of collecting seeds of native plants intended for exchange purposes.

In August, 1917, the Board published Botanical Bulletin No. 4, "The Ohia Lehua Trees of Hawaii," being a revision of the Hawaiian species of the genus *Metrosideros,* with especial reference to the Hawaiian species and varieties. It is a 76 page bulletin with 31 plates, and is based on the researches by the writer on material in the Board's herbarium now in the safe keeping of the College of Hawaii. In 1917 he also published a book on "The Ornamental Trees of Hawaii." While not an official publication, it is intimately connected with the work done by the writer as Consulting Botanist.

Seeds of numerous species of plants were imported by the writer and turned over to the Board. He personally collected quantities of seed of *Acacia arabica,* a very valuable dry district tree, from a tree growing in Mrs. Mary E. Foster's garden on Nuuanu Avenue. These seeds were distributed to numerous individuals throughout the Territory. He also imported seeds of various species of *Atriplex,* (Salt bushes) from the Agricultural Station at Giza, Egypt. These were distributed to various ranches in the islands, especially to the dry district (sheep) ranches, as on Molokai.

He also rendered services in determining plants for the Board and other parties in the Territory. It may be remarked that he completed his monograph on the Hawaiian lobelias, based partly on material in the Board of Agriculture herbarium. A duplicate set of the plants properly identified and labeled has been turned over to the Board. The monograph is being published by the Bernice P. Bishop Museum and comprises over 400 pages and 218 plates.

He also prepared a bulletin on "The Arborescent Indigenous Legumes of Hawaii," which is ready to go to press as Botanical Bulletin No. 5 of the Board of Agriculture and Forestry. It may also be of interest to note that the writer has prepared a paper treating all the leguminous plants found in the Territory, both cultivated and wild. The paper will be published with illustrations by the Hawaiian Sugar Planters' Experiment Station.

In cooperation with the Board of Health, at the request of the Executive Officer of the Board of Agriculture and Forestry, the writer has determined medicinal plants collected by a kahuna and has cooperated with the Board of Health in making a list of Hawaiian plants known to be of medicinal value.

During the summer of 1918, the writer visited the islands of Hawaii and Maui for the purpose of collecting and making notes on Hawaiian forest conditions. In conjunction with Mr. A. J. W. Mackenzie, the Forest Ranger at 29 Miles, Hawaii, he spent two days traversing and exploring the forest reserve lands near Kulani, entering the forest below 29 Miles, and ascending to the top of Kulani on the slopes of Mauna Loa.

While on Maui he ascended Haleakala and entered the forest reserve back of Puunianiau as well as the forest reserves northeast of Olinda to Waikamoi and Puohaokamoa. The condition of the forest near Waikamoi is not so good as that of Puohaokamoa. Numerous weeds have made their appearance which are penetrating into the forest, notably Hilo grass. As it was a very clear day the writer could overlook the whole forested area on that side of Haleakala into Keanae and the numerous dead ohia trees at an elevation of 3,500 feet to 4,000 feet gave the landscape a sad appearance. At Puohaokamoa the forest is in splendid condition, sphagnum moss covers the ground and the trunks of trees, the whole making a very formidable and impenetrable jungle.

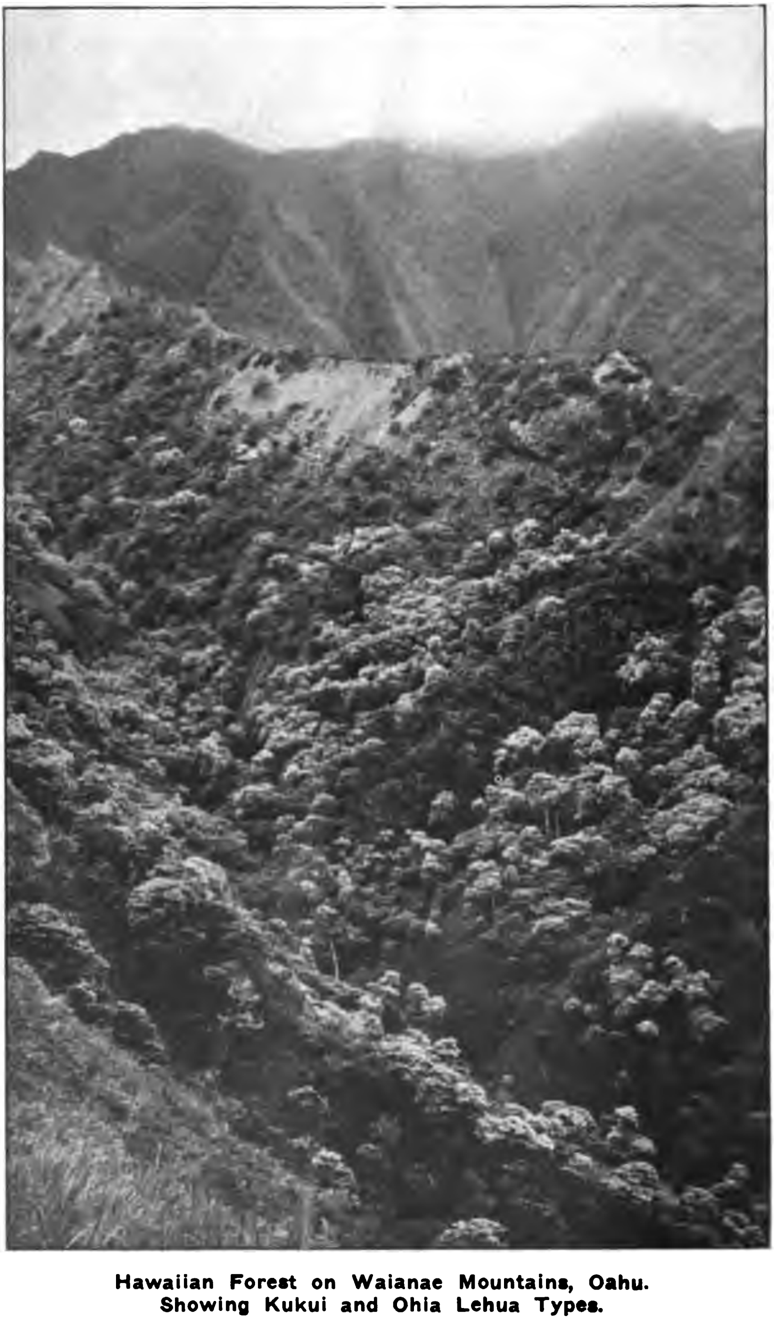
On west Maui the writer ascended the summit of Mauna Eeke in company with Mr. H. B. Penhallow of Wailukn. The day was perfect and the writer took many photos and notes, and collected many plants. Mauna Eeke is a great flat depression with much standing water—large pools with islands. The whole vegetation is very stunted and only a few inches high, with the exception of the true lobelias which measure several feet in height. The vegetation is mainly composed of a species of silversword which abounds by the thousands, lobelias, geraniums, violets, scaevola, rushes and grasses, all peculiar to that mountain summit. The vegetation is somewhat different from that of Puukukui, 1000 feet higher than Eeke, silversword are very sparingly represented on the former mountain, while thousands of individuals inhabit the latter. Eeke is furrowed by many volcanic fissures of enormous depth as well as many huge volcanic circular blow holes on the margins of which we find the true lobelias very numerous.

He also visited Waihee Valley. The trail was entirely overgrown so that it was necessary to walk in the stream bed. The vegetation is very dense and there is no danger of forest extermination, so long as the summit swamps back of the valleys are not tampered with.

Respectfully submitted,

JOSEPH F. ROCK,
Consulting Botanist.

Plate 1.



Hawaiian Forest on Waianae Mountains, Oahu.
Showing Kukui and Ohia Lehua Types.

REPORT

OF THE

Board of Commissioners of Agriculture and Forestry

OF THE

Territory of Hawaii

FOR THE

Biennial Period Ended December 31, 1918

The New Freedom Press
Honolulu, T.H.
1919

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Board of Agriculture and Forestry

Report of the Commissioners

Honolulu, Hawaii, December 31, 1918.

Hon. C. J. McCarthy,
Governor of Hawaii,
Honolulu, Hawaii.

Sir: The Board of Commissioners of Agriculture and Forestry has the honor to present herewith its report for the biennial period ended December 31, 1918.

PERSONNEL AND MEETINGS.

During the past two years the personnel of the Board has remained the same as during the previous biennial period and has held thirty-four regular and special meetings and four joint meetings with the Governor for public hearings relating to forest reserves.

PUBLICATIONS.

The following publications have been issued during the biennial period:

DIVISION OF FORESTRY.

Rule IV—Concerning the protection of bird, animal and vegetable life on certain islands of the Territory, July 28, 1917.

Botanical Bulletin No. 4—"The Ohia Lehua Trees of Hawaii," by Joseph F. Rock, August, 1917.

Reprint from The Hawaiian Forester and Agriculturist—"Forestry as Applied in Hawaii," by C. S. Judd. Vol. XV., No. 5, May, 1918.

DIVISION OF ENTOMOLOGY.

Bulletin No. 4—"The Corn Leaf Hopper," by D. T. Fullaway, December 27, 1918.

DIVISION OF PLANT INSPECTION.

Rule I, Amended—Concerning the importation of fruits, plants, etc., June 8, 1918.

Rule III., Amended—Concerning the importation of rice, June 8, 1918.

Rule XIX.—Concerning the introduction of pineapple plants, etc., June 8, 1918.

DIVISION OF ANIMAL INDUSTRY.

Rule X—Concerning anthrax quarantine on Kauai, April 20, 1917.
Rule XI—Concerning anthrax quarantine on Oahu, May 25, 1917.
Rule XII—Concerning anthrax quarantine on Maui, June 13, 1917.
"Regulations Governing the Importation of Live Stock and Other Animals into the Territory of Hawaii." June 8, 1918.

MONTHLY PUBLICATION OF THE BOARD.

Vols. XIV., 1917, and XV., 1918, "The Hawaiian Forester and Agriculturist."

ORGANIZATION.

The Board as now organized consists of four Divisions—Forestry, Entomology, Plant Inspection, and Animal Industry—and under each of these during the past biennial period much efficient work has faithfully been accomplished with direct beneficial results to the Territory.

The Division of Hydrography continued with this Board until March 23, 1917, when by Act 27 of the 1917 Legislature it was transferred together with all materials, equipment, supplies, and appropriations to the Commissioner of Public Lands with whose office the work and objects of the Division were more closely related.

By Act 206 of the 1917 Legislature the Territorial Marketing Division was on July 1, 1917, placed under the control of this Board and operated with us for one year until June 30, 1918, when by Act 25 of the special session of the Legislature of 1918 it was transferred to a special commission. This year was the most successful in the history of the division; 2,239 consignments of different kinds of island products were received and sold for $172,391.76, an increase of $50,878.85 over the previous year's sales; old debts were paid off; a new system of bookkeeping inaugurated; and the workings of the division were improved so that it became of greater service to the producers and small farmers in the Territory.

DIVISION OF FORESTRY.

The work of this division has continued to be chiefly forest protection and forest extension and much progress has been made in these two lines during the past year. A turning point has been reached in forest protection in that the work of setting apart the main forest reserve system has been completed. A fair amount of fencing of forest reserve boundaries to keep out injurious stock has been accomplished and the protective field force of seven forest rangers has done good work patrolling for forest fires and trespass of all kinds, repairing and building fences, removing stock, participating in tree planting, and taking general care of the protected forest. The underlying motive for forestry in Hawaii is water production and, therefore, in the planting work the greatest attention has been given to reforesting depleted areas on watersheds which supply districts, towns, and communities with their water supply for agricultural and domestic use.

FOREST PROTECTION.

In treating our native forests as water producers it is essential that they be managed as protection forests rather than as producers of wood and timber. Adequate patrol against trespass, fencing against stock, riddance of stock, and reforestation have therefore constituted the main work.

ADMINISTRATIVE FIELD FORCE.

This, in addition to the gangs of tree planters, was increased during the two years to seven forest rangers so that now there are two regularly employed rangers on Kauai, three on Oahu, one on Maui, and one on Hawaii to look out for the forest reserve interests. The addition of three more on Hawaii is desirable.

NEW FOREST RESERVES.

During the past two years the work of setting apart the general forest reserve system was completed by the addition of nine new forest reserves, comprising 44,476 acres, to reserves already set aside. These were the Papapaholahola Spring, Nonou and Puu Ka Pele on Kauai, the Waiahole, Mokuleia and Hauula on Oahu, and the Panaewa, Keauohana, and Olaa on Hawaii. Additions were also made to the Makua-Keaau on Oahu and the Makawao on Maui, as well as minor eliminations for road and exchange purposes. The island of Kahoolawe was also withdrawn as a forest reserve and returned to the jurisdiction of the Land Office where it can be managed to better advantage.

The number of forest reserves in the Territory now amounts to 47 with a net area of 814,926 acres, of which 554,882 acres or 68% is government land.

PROTECTION OF BIRD LIFE.

In carrying out the wishes of the last Legislature as expressed by Act 214 relating to the protection of bird, animal, and vegetable life on certain small coastal islands off Oahu, the Board passed Rule IV of the Division of Forestry which was approved by the Governor on July 28, 1917. Signs were placed on most of the islands to warn against trespass and in the enforcement of this rule twenty-two offenders have been arrested and sentenced. This has had a salubrious effect against further trespass and the native bird life on these islands has been greatly benefitted by the above action.

FOREST FENCING.

The construction of new fences on forest reserve boundaries during the two years on three main islands amounted to 14.42 miles and by the repairing of 4.21 miles of old fences a total of 18.63 miles of boundary was made stock-proof during the period. During the past fourteen years, since the setting apart of the first forest reserve, a total to date of 58.11 miles of forest reserve boundaries have thus been made impassable to stock, which is the chief enemy of the susceptible native forest.

REMOVAL OF WILD STOCK.

This fencing has been followed up by stock removal from the reserves and from figures obtained, which at least are very convative, during the biennial period 129 wild cattle, 397 wild pigs and 141 wild goats (exclusive of Kahoolawe) have been eliminated from forest reserves on three of the main islands. Legislation allowing the killing of wild branded cattle on fenced reserves, where the owner is not known, after published notice, is desired.

FOREST FIRES.

The Territory has been singularly fortunate in escaping damage by forest fires during the period in spite of some very dry weather. Only five fires, mostly in grass and brush, occurred, none of which did any considerable damage, due to the vigilance and efforts of our District Fire Warden system which has been kept in working order by many new appointments.

FOREST EXTENSION.

Forest reserve demarcation, boundary fencing, and elimination of stock from forest reserves must be followed up by bringing back a forest cover on depleted areas. This extension of the forest is accomplished by the artificial means of tree planting where nature is not able to overcome the difficulties which oppose natural regeneration.

TREE INTRODUCTION.

The native koa tree has been used extensively in our tree planting work on the reserves with success but in some situations where the soil is not well drained other trees will grow better. The

Division of Forestry is introducing and trying out new trees which are suitable for watershed cover to supplement the native forest and during the past period with the assistance of the Consulting Botanist and others many new trees from the Philippines and elsewhere have been brought in and planted in different places to test their adaptability to this climate.

TREE PROPAGATION AND DISTRIBUTION.

During the biennial period the three distributing nurseries of the Division sent out 651,411 forest, shade, and ornamental trees to homesteaders, agriculturists, army posts, ranchers, and plantations throughout the Territory. On Arbor Day in 1917, 12,111 trees and in 1918, 11,964 trees were distributed for planting on this occasion and much advice and assistance has been rendered in matters pertaining to tree planting.

A new forest nursery has been established on a forest reserve in the Waianae Mountains where a good start has been made in reforesting the rugged hills in this dry region where fresh water is at a premium It is greatly desired to establish several other nurseries in regions where the conservation of water is essential.

TREE PLANTING ON FOREST RESERVES.

Such work has been almost entirely confined to watershed areas and particularly to the water-producing region back of Honolulu. Tree planting has been in operation in five different localities with a total of 44,444 trees set out and cared for. The planting of koa trees in the Makiki Valleys has been continued, all of the vacant government reserve land in Manoa Valley has been reforested mostly with koa, and extensive plantings have been made at Lualualei on Oahu, and at Papapaholahola Spring and Kamalomalo on Kauai.

The results of experimental planting on Haleakala, Maui, show that temperate zone coniferous trees, such as the Jeffrey pine of California do well at an elevation of 6,700 feet with a height growth in eight years of 11 feet and a diameter of 3½ inches. Of 18 different kinds of new Eucalyptus trees set out in Nuuanu Valley the blackbutt shows up best with a yield of 4½ cords per acre after five years of growth.

TREE PLANTING ON PRIVATE LANDS.

Reports which have been turned in show that during the past two years a total of 1,632,598 trees has been planted throughout the Territory mostly on private lands. This is only slightly less than the number planted during the previous two years. The greater number was planted for purposes of watershed cover followed by planting for fuel production.

MISCELLANEOUS.

Other activities of the Division of Forestry, which have taken secondary place, have been cooperation with the Land Office in rendering assistance on technical forestry questions, establishing a policy and putting into operation a plan for issuing permits for summer camps on the high tableland in the Kauai mountains, the display of an exhibit at the first territorial fair, assisting in the eradication of new plant pests, and issuing publications on forest questions of general interest.

RECOMMENDATIONS.

Now that the work of setting apart forest reserves has been completed and a good start has been made in actual forest administration, it is essential and desired that means be provided to continue and extend this worthy work more particularly by providing for a few additional forest rangers, for the additional fencing of reserve boundaries and for new nurseries and trees planting for the conservation of water.

The report of the Superintendent of Forestry covers in detail the matters here merely outlined and is followed by a list of the Fire Wardens, Forest Rangers, and District Foresters and by reports of the Forest Nurseryman and Consulting Botanist.

DIVISION OF ENTOMOLOGY.

Previous to July 1, 1917, the work of this division fell into two distinct and separate lines, involving separate duties and responsibilities, viz.: 1. True entomological work such as beneficial insect introduction, propagation and distribution and general entomological work and 2, Plant quarantine and inspection work. It seemed best, therefore, to make of this old division two new ones and this was accomplished on July 1, 1917, by authority of Act 66 of the Session Laws of 1917, without increasing the force. The change has worked out very well and greatly to the advantage of the Territory.

The work of the new Division of Entomology has been confined during the period principally to the propagation and distribution of beneficial insects. Unsettled traveling facilities due to the war have made it inadvisable to undertake any new introductions and although the main work has as a consequence been concentrated on the distribution of introductions already made, new projects have at the same time been investigated so that they can be taken up in the field when the opportunity presents itself.

The beneficial insects handled by the division during the two years have been the corn leaf hopper egg parasite, the fruit fly and melon fly parasites, dung fly parasites and others, of which over half a million have been propagated and distributed to control pests in many parts of the Territory. A great deal of benefit has accrued to the rancher and small farmer by assisting nature in this way.

A special study was made by the Entomologist of the corn leaf hopper and its parasites which resulted in an instructive bulletin on the subject. The effectiveness of these parasites is proved by the high amount of parasitism secured which has averaged close to fifty per cent.

Fortunately, no new pests of any moment appeared during the biennial period but since the appearance of a really dangerous new insect is not an impossibility, it is well to be prepared for emergencies and to have available sufficient funds with which to combat it by every means known to science.

DIVISION OF PLANT INSPECTION.

The work of this new division has been greatly strengthened and facilitated by separating it from the other activities of the old Division of Entomology which has made it possible to concentrate on the important work of fruit and plant inspection and quarantine at the waterfront. This reorganization which took place on July 1, 1917, was followed by the erection of a suitable and substantial concrete building on land set aside by the Governor on Kekuanaoa Street, Honolulu, which contains the offices of the inspectors, plant and quarantine room, laboratory, incinerator, and library. This is supplemented by two airtight concrete fumigating units which are constantly used to rid shipments of pests. These buildings were first occupied at the end of 1917, and all old equipment which was scattered on the various wharves was assembled in this new location. Since then, all work pertaining to the inspection of plants has been carried on with greater safety at this new station.

IMPORTATION INSPECTION.

As in previous years, the main activities of this division have consisted of inspecting at Honolulu all fruits, vegetables, plants, and seeds in the attempt to prevent the introduction of new pests from foreign countries and the movement of pests from Honolulu, the port of entry, to ports on the other islands. The work in Honolulu has been supplemented by inspections at Hilo and Kahului.

During the two years 1,433 vessels arriving at these three ports from foreign and mainland ports were given attention. Of these, 614 vessels carried vegetable matter consisting of 566,268 packages of fruit and vegetables, seeds, and plants. Of these, over 7,000 packages were either burned, fumigated before delivery, or returned to the shipper on account of being infested with insect pests or fungus diseases or being contraband under the rulings of the Federal Horticultural Board.

INTER-ISLAND INSPECTION.

During the period under review 1,396 steamers plying between Honolulu and other island ports received attention, and of the 24,114 packages of plants, fruits, and vegetables inspected, 330 packages were rejected on account of infestation or having undesirable soil attached to the roots of plants.

RULES AND REGULATIONS.

The rules and regulations pertaining to the shipment of plants, fruits, seeds, etc., from the mainland and foreign countries and pertaining to rice shipments from Japan were amended so as to make them more stringent and a new rule was passed to prohibit the importation of pineapple plants and suckers from the West Indies and Central America in the effort to keep out a pineapple beetle which does serious damage to pineapples in Jamaica.

COOPERATION.

The work of the division has been greatly facilitated by the cooperative assistance rendered by the post office and customs officials in allowing the inspection and destruction of prohibited plants, etc., and by the Federal Horticultural Board which imposes restrictive measures on horticultural imports which have given greater security against the danger of introducing foreign insect pests and plant diseases.

The continuation of plant inspection work is of the utmost importance to the agricultural interests in the Territory and an adequate appropriation for its maintenance on an efficient basis is respectfully requested.

DIVISION OF ANIMAL INDUSTRY.

The most noteworthy achievements of this division during the past two years were the successful suppression of an outbreak of anthrax on three of the islands and the progress made toward the total eradication of bovine tuberculosis from the Territory. Both of these diseases are transmissible to man, and for this particular reason the special efforts of the territorial veterinarians were directed toward their suppression. Both of these achievements have been made possible by special appropriations of the Legislature which have been most timely. Beyond anthrax and bovine tuberculosis the Territory has been singularly free from animal diseases of any kind during the biennial period and the rigid inspection that is made of all imported live stock has continued to keep out obnoxious animal diseases which are rampant elsewhere

LIVE STOCK CONDITIONS IN GENERAL.

The development of mule breeding in the Territory, especially on the Parker Ranch, has met with such signal success that it should be unnecessary in the future to import the heavier mules required for wagons and field plowing and cultivation on the plantations.

The beef cattle industry is also established on a sound basis so that the islands are self supporting in this respect but an entirely too limited number of breeding stock for dairy purposes has been imported to make the necessary improvement that is required to prevent the dairy industry of the Territory from going to pieces.

Hog raising has improved steadily both as to quality and quantity and this industry can now take care of the local demand.

The sheep industry is gradually being crowded out by cattle raising and poultry and eggs are imported in steadily increasing quantities due to the high cost of imported feed.

The importations of horses, pure bred cattle and sheep have increased during the period under review while the importations of mules and of swine have fallen off considerably.

RULES AND REGULATIONS.

In order to keep up to date with recent legislation enacted by Congress and the various states pertaining to livestock in interstate and foreign trade the regulations of this division governing the importation of live stock and other animals into the Territory were revised and upon approval by the Governor went into effect on June 8, 1918.

On July 28, 1917, Rule VII pertaining to the transfer of hogs from Oahu to other islands was rescinded for the reason that it was no longer considered necessary, hog cholera not having appeared on Oahu for more than a year.

Rules X, XI and XII placing a quarantine on the islands of Kauai, Oahu, and Maui, respectively, were promulgated during the summer of 1917 on account of the anthrax epidemics. The first still remains in force with certain modifications.

Rule XIII requiring a permit to keep Belgian hares and other rabbits was promulgated on October 30, 1917, to comply with Act 50 of the Session Laws of 1917.

THE ANTHRAX OUTBREAKS.

Anthrax, hitherto unknown in the Territory, and which could have been only introduced maliciously, made its first appearance on Kauai in April, 1917, followed by an outbreak on Oahu in May, and several outbreaks on Maui in June. It fortunately was prevented from reaching Hawaii. The prompt action of the Legislature then in session in providing liberal means wherewith to fight the outbreaks contributed to the effectiveness with which the epidemics were combatted. On Kauai and Oahu the disease was confined by stringent quarantine measures to the premises where it first made its appearance and the outbreaks on Maui were similarly confined though widely scattered.

On Oahu the United States Army rendered generous aid by furnishing guards for the quarantined area and on Kauai the County government rendered liberal support. The prompt action of the division in securing a supply of serum vaccine with which all exposed animals were vaccinated, the quarantine of all pastures in the region of infection, and the disposal of all carcasses by cremation were effective in confining the loss to less than five hundred head of cattle and horse stock and brought the epidemy to a complete standstill on Oahu and Maui before the fall of the same year. In the infected district on Kauai only two cases have occurred in 1918 and the last one of these more than seven months ago.

Since the infection may remain in the soil for years, the preventive measure of vaccination and constant vigilance must be continued on Kauai for an indefinite period and an appropriation for these measures is required.

BOVINE TUBERCULOSIS CONTROL.

The campaign for the eradication of bovine tuberculosis in the dairy herds of the Territory was continued with good results during the period under review and was greatly aided by the indemnification act passed by the last Legislature. Less tuberculosis was found in those dairies known to be heavily infected than at any time in their previous history and by the liberal compensation to owners of condemned animals the opposition of dairy owners has subsided so that the prospects of complete eradication can be said to have come within reach.

Under the authority of Act 121 of the Session Laws of 1917, 9,577 head of cattle were tested and 453, found to be affected with tuberculosis, were condemned. These were appraised at an aggregate of $40,265, and after slaughter and inspection the wholesome parts of the carcasses were sold for $17,674.66. The owners consequently received on the average $83.76 per head for such condemned animals.

Altogether this law has given general satisfaction and has materially aided the dairymen in their efforts to clean up their herds by removing infected animals which have been a menace to the healthy animals in the herd and which were unprofitable milk producers and which either were or might become at any time dangerous to human beings.

A few minor improvements in the present law, based on the experience of the past two years are desired, and it may be expected that with a smaller appropriation during the coming biennial period together with what federal aid is forthcoming the continuation of the tuberculosis eradication work will see the end of the infection in the Territory.

CONCLUSION.

In concluding this report, the Commissioners desire to lay emphasis on the efficient work which has been performed for the benefit of the Territory at large by the several Divisions, the reports of which follow herewith in detail. It is confidently hoped that the Board and its four Divisions will receive adequate support, both financially and otherwise, for the continuation of these important lines of work.

Respectfully submitted,

A. H. RICE, President.
W. M. GIFFARD.
J. M. DOWSETT.
H. M. vonHOLT.
A. L. C. ATKINSON.
Commissioners.

STATEMENT OF BALANCES ON HAND DECEMBER 31, 1916.

Appropriations—1914-1916.

GENERAL FUND.

Balance on hand, December 31, 1916			$101,040.34
Expended January 1, 1917, to June 30, 1917.			
Board of Administration:			
Wages	$3,036.00		
Expenses	3,795.57		
		$6,831.57	
Division of Forestry:			
Wages	$10,087.40		
Expenses	4,554.51		
		$14,641.91	
Division of Entomology:			
Wages	$6,301.46		
Expenses	1,815.31		
		$8,116.77	
Division of Animal Industry:			
Wages	$5,880.00		
Expenses	2,824.75		
		$8,704.75	
Territorial Marketing Division:			
Wages and Expenses		$5,961.49	
Glenwood Experimental Station:			
Wages and Expenses	$1,780.25		
Traveling Expenses	361.60		
		$2,141.85	
Division of Hydrography:			
Wages	$2,556.21		
Expenses	832.49		
		$3,388.70	
Total expended			49,787.04
Balance June 30, 1917			$51,253.30
Control, Suppression and Eradication of Anthrax, Special Appropriation made April 27, 1917		$25,000.00	
Expenses		6,362.54	
			$18,637.46

BOARD OF AGRICULTURE AND FORESTRY.

(Appropriations by Legislature of 1917.)

Board of Administration:		
Salary, Executive Officer and Superintendent of Forestry	$8,400.00	
Expended 18 months to Dec. 31, 1918	6,300.00	
Unexpended balance, Dec. 31, 1918		$2,100.00
Salaries and Wages, employees	9,840.00	
Expended, 18 months to Dec. 31, 1918	7,207.50	
Unexpended balance, Dec. 31, 1918		$2,632.50
Expenses	5,520.00	
Expended 18 months to Dec. 31, 1918	3,976.03	
Unexpended balance, Dec. 31, 1918		$1,543.97

Division of Forestry:		
Salary, Forest Nurseryman	4,440.00	
Expended 18 months to Dec. 31, 1918	3,330.00	
Unexpended balance, Dec. 31, 1918		$1,110.00
Rangers and Nursery Agents, Hilo	9,240.00	
Expended 18 months to Dec. 31, 1918	5,610.00	
Unexpended balance, Dec. 31, 1918		$3,630.00
Wages of laborers	31,600.00	
Expended 18 months to Dec. 31, 1918	17,553.94	
Unexpended balance, Dec. 31, 1918		14,046.06
Expenses	20,000.00	
Expended 18 months to Dec. 31, 1918	11,937.79	
Unexpended balance, Dec. 31, 1918		8,062.21
Division of Entomology:		
Salary, Entomologist	6,000.00	
Expended 18 months to Dec. 31, 1918	4,500.00	
Unexpended balance to Dec. 31, 1918		1,500.00
Salaries, Assistants	3,480.00	
Expended 18 months to Dec. 31, 1918	1,745.00	
Unexpended balance, Dec. 31, 1918		1,735.00
Expenses	5,000.00	
Expended 18 months to Dec. 31, 1918	1,424.79	
Unexpended balance, Dec. 31, 1918		3,575.21
Collecting and Introducing Parasites		10,000.00
Division of Plant Inspection:		
Salary, Chief Plant Inspector	6,000.00	
Expended, 18 months to Dec. 31, 1918	4,500.00	
Unexpended balance Dec. 31, 1918		1,500.00
Salaries, Inspectors	11,400.00	
Expended, 18 months to Dec. 31, 1918	7,976.29	
Unexpended balance Dec. 31, 1918		3,423.71
Expenses	5,000.00	
Expended, 18 months to Dec. 31, 1918	2,782.84	
Unexpended balance Dec. 31, 1918		2,217.16
Division of Animal Industry:		
Salary, Territorial Veterinarian	6,000.00	
Expended, 18 months to Dec. 31, 1918	4,500.00	
Unexpended balance Dec. 31, 1918		1,500.00
Salary, Asst. Territorial Veterinarian	4,800.00	
Expended, 18 months to Dec. 31, 1918	3,600.00	
Unexpended balance Dec. 31, 1918		1,200.00
Salary, Livestock Inspector	3,120.00	
Expended, 18 months to Dec. 31, 1918	2,340.00	
Unexpended balance Dec. 31, 1918		780.00

Salaries, Deputy Veterinarians and Caretakers, Quarantine Stations	10,080.00	
Expended, 18 months to Dec. 31, 1918	7,380.00	
Unexpended balance Dec. 31, 1918		2,700.00
Expenses	8,000.00	
Expended, 18 months to Dec. 31, 1918	6,695.70	
Unexpended balance Dec. 31, 1918		1,304.30
Glenwood Experiment Station:		
Salary, Superintendent	3,600.00	
Expended, 18 months to Dec. 31, 1918	2,700.00	
Unexpended balance Dec. 31, 1918		900.00
Expenses and Assistants	2,400.00	
Expended, 18 months to Dec. 31, 1918	1,905.03	
Unexpended balance Dec. 31, 1918		494.97
Traveling Expenses, Superintendent	1,200.00	
Expended, 18 months to Dec. 31, 1918	902.11	
Unexpended balance Dec. 31, 1918		297.89
Territorial Marketing Division:		
Salary, Superintendent	6,000.00	
Expended, 12 mos. to June 30, 1918	2,163.97	
Unexpended balance June 30, 1918		3,836.03
Salaries and Expenses	24,000.00	
Expended, 12 mos. to June 30, 1918	11,640.93	
Unexpended balance June 30, 1918		12,359.07
Food Crop Production	5,000.00	
Expenses, 12 mos. to June 30, 1918	2,348.35	
Unexpended balance June 30, 1918		2,651.65
Control, Suppression and Eradication of Anthrax, Special appropriation made April 27, 1917	25,000.00	
Expended to Dec. 30, 1918	24,999.54	
Unexpended balance Dec. 31, 1918		.46
Control, Suppression and Eradication of Anthrax, Special appropriation made May 31, 1918	1,757.11	
Expended June, 1918	1,757.11	
To Prevent, Suppress and Eradicate Bovine Tuberculosis, Special appropriation made April 23, 1917	20,000.00	
Expended to Dec. 31, 1918	15,972.38	
Unexpended balance Dec. 31, 1918		4,027.62
Preservation, Extension Forestry and Forest Reserves:		
Balance on hand December 31, 1916	3,572.50	
Receipts to Dec. 31, 1918	658.25	
		4,230.75
Expended to Dec. 31, 1918		19.46
Balance on Deposit Dec. 31, 1918		4,211.29

DETAILS OF EXPENDITURES.
January 1, 1917, to December 31, 1918.

	1917 6 mos. Jan. 1, to June 30, 1917	1917 6 mos. July 1, to Dec.31, 1917	1918 12 mos. Jan. 1, to Dec. 31, 1918	18 mos. July 1, '17 to Dec. 31, 1918	Total 24 mos. Jan. 1, '17 to Dec. 31, 1918
Board of Administration:					
Salaries and Wages:					
Executive Officer	$ 600.00				$ 600.00
Executive Officer and Supt. of Forestry		$2,100.00	$4,200.00	$ 6,300.00	6,300.0
Salaries and Wages, employees	2,436.00	2,438.25	4,874.25	7,312.50	9,748.50
	$3,036.00	$4,538.25	$9,074.25	$13,612.50	$16,648.50
Expenses:					
Routine	$ 765.35	$ 179.13	$ 340.34	$ 519.47	$1,284.82
Supplies	998.79	1,107.49	1,094.71	2,202.20	3,200.99
Transportation	24.75	20.00	40.50	60.50	85.25
Publications	1,792.47	8.00	226.40	234.40	2,026.87
Maintenance of Building	214.21	144.55	814.91	959.46	1,173.67
	$3,795.57	$1,459.17	$2,516.86	$3,976.03	$7,771.60
Division of Forestry:					
Salaries and Wages:					
Superintendent of Forestry	$1,500.00				$1,500.00
Assistants and Employees	8,587.40				8,587.40
Forest Nurseryman		$1,110.00	$2,220.00	$3,330.00	3,330.00
Rangers and Nursery Agents		1,690.00	3,920.00	5,610.00	5,610.00
Wages of Laborers		5,566.69	11,987.25	17,553.94	17,553.94
	$10,087.40	$8,366.69	$18,127.25	$26,493.94	$36,581.34

Expenses:					
Routine	$1,816.88	$1,644.18	$ 757.78	$2,401.96	$4,218.84
Transportation	1,385.11	616.79	2,330.10	2,946.89	4,332.00
Publications	217.17	1,346.05	459.66	1,805.71	2,022.88
Supplies	39.52		352.39	352.39	391.91
Planting		58.85	1,033.65	1,092.50	1,092.50
Fencing	1,095.83	65.75	3,098.09	3,163.84	4,259.67
Maintenance of Building			125.00	125.00	125.00
Forest Fires		49.50		49.50	49.50
	$4,554.51	$3,781.12	$8,156.67	$11,937.79	$16,492.30
Division of Entomology:					
Salaries and Wages:					
Superintendent of Entomology	$1,500.00				$1,500.00
Parasitic Work	$1,500.00	1,500.00	3,000.00	4,500.00	6,000.00
Assistants and Employees	3,301.46	395.00	1,350.00	1,745.00	5,046.46
	$6,301.46	$1,895.00	$4,350.00	$6,345.00	$12,546.46
Expenses:					
Insectary	$ 247.98	$ 12.50	$ 206.45	$ 218.95	$ 466.93
Supplies	398.87	111.57	115.28	226.85	620.72
Transportation	383.90	10.00	650.31	660.31	1,044.21
Publications	789.56	35.66	283.02	318.68	1,108.24
Division of Plant Inspection:	$1,815.31	$ 169.73	$1,255.06	$1,424.79	$3,240.10
Salaries and Wages:					
Plant Inspector					
Salaries, Inspectors		$1,500.00	$3,000.00	$4,500.00	$4,500.00
		2,651.29	5,325.00	7,976.29	7,976.29
		$4,151.29	$8,325.00	$12,476.29	$12,476.29
Expenses:					
Routine		$ 124.80	$ 113.34	$ 238.14	238.14
Supplies		382.76	227.64	610.40	610.40
Publications			153.63	153.63	153.63
Transportation		164.50	345.66	510.16	510.16
Maintenance of Building			1,270.51	1,270.51	1,270.51
		$ 672.06	$2,110.78	$2,782.84	$2,782.84

Division of Animal Industry:					
Salaries and Wages:					
Territorial Veterinarian	$1,500.00	$1,500.00	$3,000.00	$4,500.00	$6,000.00
Assistants and Employees	4,380.00				4,380.00
Assistant Territorial Veterinarian		1,200.00	2,400.00	3,600.00	3,600.00
Livestock Inspector		780.00	1,560.00	2,340.00	2,340.00
Deputy Ter. Veterinarians and Caretakers, Quarantine Stations		2,490.00	4,890.00	7,380.00	7,380.00
	$5,880.00	$5,970.00	$11,850.00	$17,820.00	$23,700.00
Expenses:					
Quarantine Station	$ 502.12	$1,210.63	$1,153.84	$2,364.47	$2,866.59
Supplies	$ 779.58	113.70	1,054.11	1,167.81	1,947.39
Transportation	1,543.05	194.85	2,500.74	2,695.59	4,238.64
Incidentals		139.50	52.34	191.84	191.84
Publications		66.95	209.04	275.99	275.99
	$2,824.75	$1,725.63	$4,970.07	$6,695.70	$9,520.45
Glenwood Experimental Station:					
Salaries, Wages and Expenses:					
Salary, Superintendent		$ 900.00	$1,800.00	$2,700.00	$2,700.00
Assistants and expenses	1,780.25	579.82	1,325.18	1,905.00	3,685.25
Traveling Expenses	361.60	227.02	675.09	902.11	1,263.71
	$2,141.85	$1,706.84	$3,800.27	$5,507.11	$7,648.96
Control, Suppression and Eradication of Anthrax	$6,362.54	$17,360.75	$1,276.25		$24,999.54
	$6,362.54	$17,360.75	$1,276.25		$24,999.54

	Jan. 1, 1917 to March 31, 1917	Jan. 1, 1917 to March 31, 1917
Division of Hydrography:		
Salaries and Wages:		
Stream Gaging	$1,112.23	$1,112.23
Rain Gaging	105.00	105.00
Reports, Compiling, Computing	945.93	945.93
General Office Expenses	269.70	269.70
General Supervision	79.35	79.35
Labor	44.00	44.00
	$2,556.21	$2,556.21
Expenses:		
General Office Expense	$173.26	$173.26
Subsistence, Persons, etc.	189.05	189.05
Travel Charges	220.56	220.56
Equipment, permanent	25.95	25.95
Supplies, expendable	70.66	70.66
Incidentals	117.46	117.46
Freight	35.55	35.55
	$ 832.49	$832.49

Division of Forestry

REPORT OF THE SUPERINTENDENT OF FORESTRY

Honolulu, Hawaii, December 31, 1918.

The Board of Commissioners of
Agriculture and Forestry,
Honolulu, Hawaii.

Gentlemen: I have the honor to submit as follows the report of the Division of Forestry for the calendar years 1917 and 1918.

INTRODUCTION.

The main activities of the Division during the past two years have been largely confined to the two important branches of forest work—protection and extension. The details of this work and what has been accomplished are set forth in the following pages.

The main underlying motive for the practice of forestry in these islands is the maintenance by forest influences of a continued and steady supply of water for the use of agricultural and domestic pursuits in the Territory. The protection and rehabilitation of the forest, therefore, for the beneficial effect which it exerts on the water supply, rather than the exploitation of the forest for timber, are striven for, and any factors which work against these main objects are detrimental to the best interests and welfare of the Territory.

The sooner this principle is understood and universally practiced by all owners of forest land in the Territory, the sooner will be attained the ultimate object of forestry in these islands. This is essential because of the intimate manner in which forest lands under different ownerships are intermingled on the several islands.

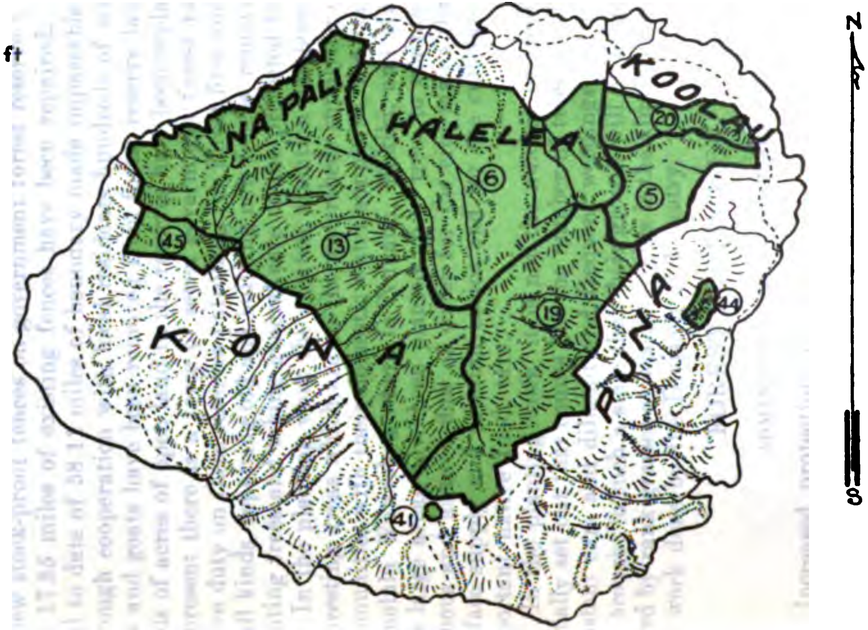
Fortunately during the past year one of the leading factors in the control of such lands, the Hawaiian Sugar Planters' Association, has seen fit to undertake the actual practice of forest protection and reforestation on forest lands under its control by establishing a Division of Forestry in its organization and by beginning work on the first unit in the Kohala Mountains. Deserved credit for the institution of this work is assigned to Commissioner W. M. Giffard, who prepared last summer a very able paper on the methods of organization for such work. The Division of Forestry of this Board will cooperate in whatever work is done by the Association wherever government forest reserve lands are involved.

In private work of this character, the Territory, represented by this Board, is more than willing to meet the private owner half-way in working out the details for any project and will gladly cooperate in any fencing project, in the employing of a ranger for mutual protection and patrol, and in nursery and reforestation projects, where government forest lands are situated on the same watershed requiring attention.

In the actual practice of forest work throughout the Territory during the past two years, several conclusions have been reached by the present incumbent at the head of the Division of Forestry which may be elucidated here. A large part of the executive work in connection not only with the demarcation of new forest reserves, which work, as will be seen later, has just been brought to a conclusion, but also with their actual field administration requires technical skill through personal effort. The simple tasks of fence repairing, driving out cattle and planting trees can be accomplished by the ordinary ranger or laborer, but the type of man at present available cannot be expected to plan and execute jobs, such as the proper selection of new nursery sites, etc., which require higher technical ability. Such work has therefore devolved upon the personal efforts of the only trained forester in this Division, and with a field of over half a million acres scattered over five different islands and separated by 360 miles of ocean and difficult land travel, not as much has been accomplished as is desired. The addition of one other technical man on the present force would make it possible to accomplish considerably more that awaits attention.

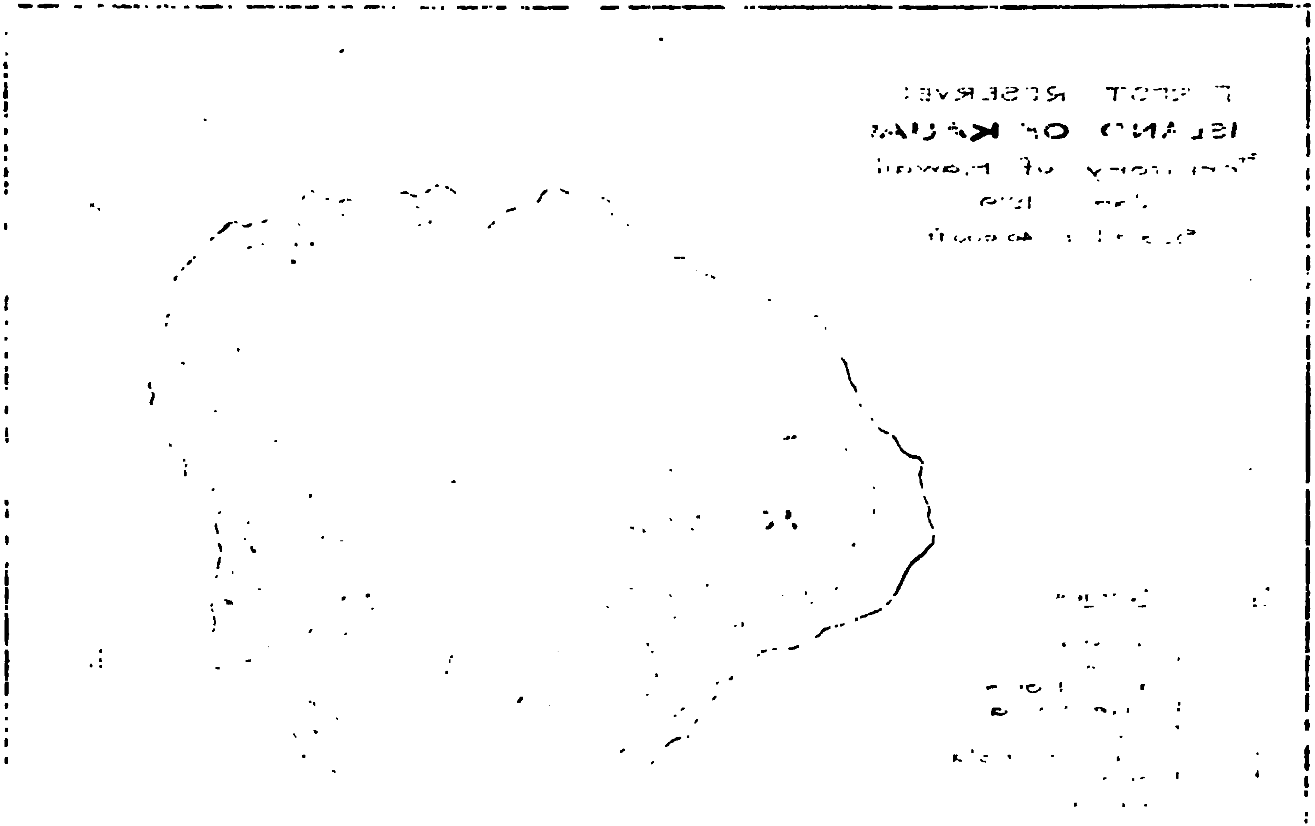
Because of the greater publicity given to the demarcation of new forest reserves through the calling of public hearings and publication of proclamations, the impression has obtained with some that this has constituted the chief work of the Division and that, when once a reserve is established on paper, further work ceases. This has been far from the truth, although in some cases it has not been possible to perform certain complete work, such as fencing, because of the disinclination of the adjacent private owner to cooperate or because of lack of adequate appropriation, or because the land under an old lease has not yet reverted to the government. It is always the plan to follow the proclamation of a new

FOREST RESERVES
ISLAND OF KAUAI
Territory of Hawaii
Jan. 1919
Scale 1 in. = 40,000 ft



No.	Names
⑥	Halelea
⑤	Kealia
⑬	Na Pali Kona
⑲	Lihue-Koloa
⑳	Moloaa
㊶	Papapaholahola
㊹	Noneu
㊺	Puu Ka Pele

Prepared by Gov't. Survey Dept. 1919


FOREST RESERVES
ISLAND OF KAUAI
Territory of Hawaii

reserve as speedily as possible with the necessary fencing and protection and large areas of established forest reserve lands are far from being mere paper reserves, for they are properly fenced and patrolled by rangers against trespass by man and beast, stock has been removed, and open areas have been reforested. The work of actual forest reserve administration has progressed at the same time with the establishment of new reserves.

During the past period of fourteen years since the setting apart of the first reserve, there have been constructed, through the efforts of the Division of Forestry so far as funds have permitted and through the cooperation of private owners and the Land Office by means of fencing clauses in general leases, a total of 40.26 miles of new stock-proof fences on government forest reserve boundaries and 17.85 miles of existing fences have been repaired, making a total to date of 58.11 miles of boundary made impassable to stock. Through cooperation with local residents hundreds of wild cattle, pigs and goats have been removed from forest reserve lands. Hundreds of acres of open land in the reserves have been replanted and at present there is a force of seven government forest rangers on active duty on these reserves patrolling for forest fires and trespass of all kinds, repairing old and building new fences, removing stock, planting trees and taking general care of the protected forest.

In the planting work the greatest attention has been given to reforesting areas which are on the watersheds supplying cities and communities with their domestic water supply as, for example, the Honolulu Watershed where in Nuuanu, Makiki, and Manoa Valleys large areas have been planted up to trees to maintain a continuous and assured flow of water for the city mains through the surface supply and artesian basins and for the cultivation of the important native food, taro.

In the planting work, it is not the number of trees that are actually set out that counts but the number of trees which through constant care and diligent and frequent weedings and cultivation are brought to such a state that their growth will no longer be hindered by rank grasses or weeds. This is the aim in all tree planting work done by the Division of Forestry.

FOREST PROTECTION.

ADMINISTRATIVE FIELD FORCE.

Increased protection has been given to forest reserve lands during the past two years by the appointment of an additional ranger on the island of Kauai and through certain changes in the personnel of the force. Ranger Kaina D. Lovell died on June 20, 1917, and was succeeded on August 1, by his son, Hosea K. Lovell as Forest Ranger for windward Kauai. On September 1, 1918,

W. V. Hardy was appointed Forest Ranger for Kauai in general and more particularly for the Waimea District. The three rangers for Oahu and one for Maui have remained the same with the exception of the additional appointment of Bruce Cartwright Jr. on August 1, 1917, as Honorary Forest Ranger for the enforcement of Rule IV of this Division on Oahu. On June 20, 1917, Ranger F. B. Dodge left our services to enlist in the navy and he was succeeded on September 28, 1917, by A. J. W. Mackenzie, who was appointed Forest Ranger for South Hawaii. These men have done good work in their respective districts in all lines of forest activity.

Now that the setting apart of the general forest reserve system has been accomplished, it will be possible to give greater impetus to the work of forest protection and extension in the form of fence building and tree planting. The services of two additional rangers for the Districts of Kau and Kona combined and for North Hilo, respectively, and of a ranger for the Kohala region in cooperation with the H. S. P. A. could be used to good advantage.

NEW FOREST RESERVES.

During the past two years the work of examining, describing, and setting apart forest reserves in the Territory, the essential first step in forest administration, was completed by the addition of nine new forest reserves comprising 44,476 acres, to the general reserve system, making a total of 47 reserves now established on the main islands throughout the group. These new forest reserves are as follows:

The Papapaholahola Spring Reserve in Kalaheo, Kona, Kauai, consisting of 54 acres of government land about the spring which supplies local residents with their water and most of which has already been planted up to trees by the Division of Forestry.

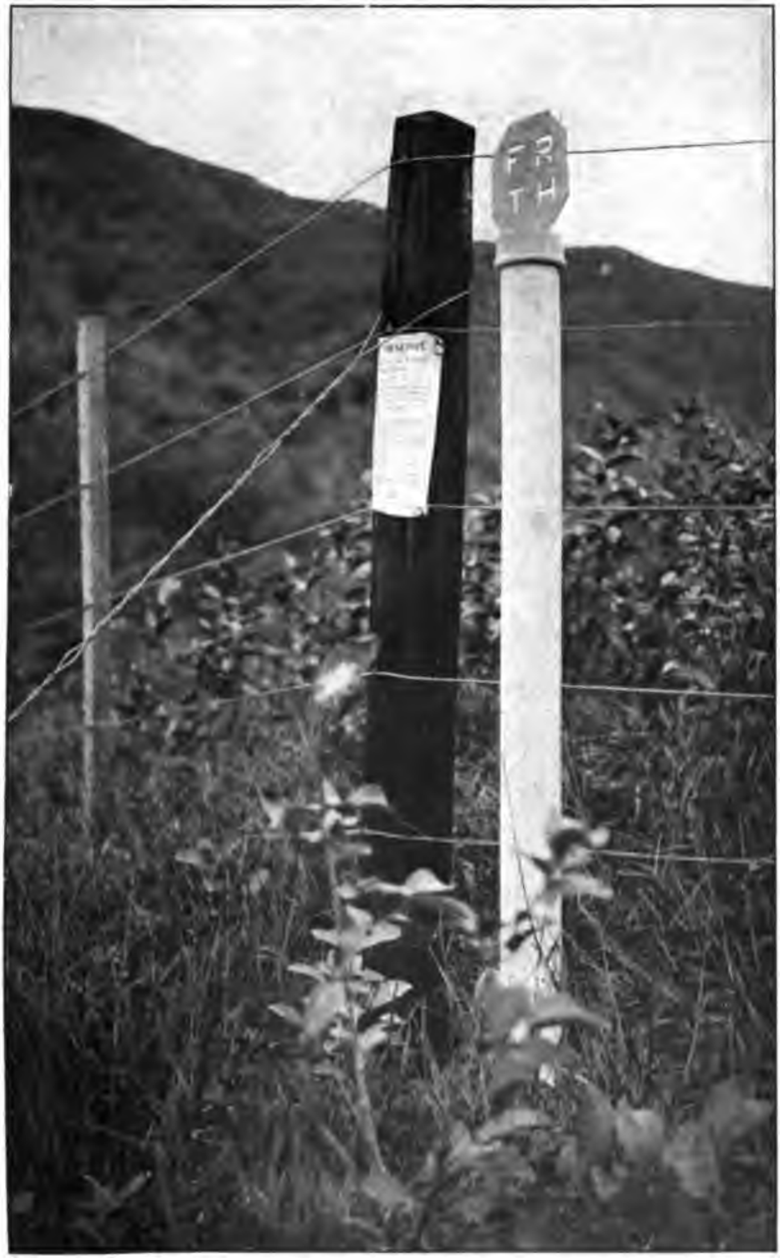
The Nonou Forest Reserve in Wailua, Puna, Kauai, consisting of 818 acres of government land on the ridge which parallels the coast and which is important for the conservation of water.

The Puu Ka Pele Forest Reserve in Waimea, Kauai, consisting of 4,900 acres of government land, which includes the scenic part of the Waimea Canyon and a large area of upland which is coming up to koa trees and is well worth protecting.

The Waiahole Forest Reserve in Koolaupoko, Oahu, consisting of 1,169 acres of which 96.5% is government land, which is important as a water-producing forest in that it embraces forest land which is a part of the Waiahole water tunnel system.

The Mokuleia Forest Reserve in Waialua, Oahu, consisting of 6,290 acres of government land above the private grants on the higher northern slopes of the Waianae Mountains which drain to

Plate 2.



Standard Forest Reserve Metal Monument and Fence, Waiahole, Oahu.

FOREST RESERVES, TERRITORY OF HAWAII.

January 1, 1919.

Name.	No.	District.	Total Area Recommended to be Reserved, Acres.	Area Govern-m't Land, Acres.	Area Private Land, Acres.	Date of Proclamation.
ISLAND OF KAUAI.						
Halelea	6	Halelea	37,500	10,990	26,510	Aug. 24, 1914
Kealia	5	Puna	9,935	7,385	2,550	Mar. 9, 1906
Na Pali Kona	13	Na Pali and Kona	60,540	40,650	19,890	June 12, 1907
Lihue-Koloa	19	Puna and Kona	29,260	13,365	15,895	June 5, 1909
Moloaa	20	Koolau	5,621	3,578	2,043	June 5, 1909
Papapaholahola Spring	41	Kona	54	54		June 19, 1918
Nonou	44	Puna	818	818		Dec. 31, 1918
Puu Ka Pele	45	Waimea	4,900	4,900		Dec. 31, 1918
			148,628	81,740	66,888	
ISLAND OF OAHU.						
Kaipapau	1	Koolauloa	913	913		Nov. 10, 1904
Ewa	7	Ewa, Waianae and Waialua	28,550	5,151	23,399	Mar. 9, 1906
Waianae-kai	10	Waianae	3,653	3,546	107	Sept. 7, 1906
Lualualei	11	Waianae	3,743	3,743		Nov. 30, 1906
Pupukea	21	Koolauloa	864	864		May 10, 1910
Nanakuli	28	Waialua	1,010	1,010		June 4, 1913
Makua-Keaau	29	Waialua	*4,820	4,480	340	June 4, 1913
Kuaokala	30	Waialua	434	434		June .., 1913
Honolulu Watershed	34	Honolulu	6,950	4,998	1,952	Oct. 13, 1913
Kuliouou	35	Honolulu	214	214		Feb. 13, 1914
Manoa Ranger Station	38	Honolulu	15	15		May 9, 1916
Round Top	39	Honolulu	115	115		Aug. 10, 1916
Waiahole	42	Koolaupoko	1,169	1,129	40	June 19, 1918
Mokuleia	46	Waialua	6,290	6,290		Dec. 31, 1918
Hauula	47	Koolauloa	9,193	1,143	8,050	Dec. 31, 1918

ISLAND OF MOLOKAI.

Molokai	26		44,674	13,268	31,406	Aug. 25, 1910

ISLAND OF MAUI.

Koolau	4	Koolau and Hamakualoa	42,969	30,230	12,739	Aug. 24, 1905
Hana	12	Hana	14,825	13,767	1,058	Nov. 30, 1906
West Maui	14	Lahaina, Kaanapali and Wailuku	44,482	19,147	25,335	Apf. 21, 1908
Makawao	15	Hamakuapoko	†2,093	2,093		Apr. 21, 1908
Waihou Spring	18	Hamakuapoko	84	74	10	June 5, 1909
Kula	27	Kula	6,075	5,069	1,006	Sept. 11, 1912
Kipahulu	36	Kipahulu and Kaupo	10,600	4,600	6,000	Aug. 20, 1914
			121,128	74,980	46,148	

ISLAND OF HAWAII.

Hamakua Pali	2	Hamakua	18,940	16,333	2,607	Dec. 23, 1904
Hilo	3	Hilo	110,000	60,223	49,777	July 24, 1905
Honuaula	8	Kona	665	665		Apr. 4, 1906
Kau	9	Kau	66,066	59,811	6,255	Aug. 2, 1906
Waiaha Spring	16	Kona	193	193		Apr. 21, 1908
Mauna Kea	17	Hamakua	66,600	66,600		June 5, 1909
Hauola	22	Hamakua	7	7		June 13, 1910
South Kona	24	Kona and Kau	36,952	29,260	7,692	May 17, 1911
Puna	25	Puna	19,850	19,850		June 29, 1911
Kohala Mt.	31	N. and S. Kohala	29,627	14,204	15,423	Oct. 13, 1913
Upper Waiakea	32	Hilo	51,800	51,800		Oct. 13, 1913
Upper Olaa	33	Puna	9,280	9,280		Oct. 13, 1913
Olaa Forest Park	37	Puna	531	531		Aug. 20, 1914
Panaewa	40	South Hilo	1,750	1,750		Apr. 11, 1917
Keauohana	43	Puna	272	272		June 19, 1918
Olaa	48	Puna	20,030	20,030		Dec. 31, 1918
			432,563	350,809	81,754	
TOTAL		ALL ISLANDS	814,926	554,842 (68%)	260,084 (32%)	

*Boundary modified and area enlarged from 4,716 to 4,820 by proclamation of Governor McCarthy, Dec. 31, 1918.
†Boundary modified and area enlarged from 1,830 to 2,093 by proclamation of Governor Pinkham, June 19, 1918.

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†Boundary modified and area enlarged from 1,830 to 2,093 by proclamation of Governor Pinkham, June 19, 1918.

RULES AND REGULATIONS.

The rules and regulations for the protection and administration of forest reserve lands, already in force, have worked out so well that it has not been found necessary to add to them by the promulgation of any new rule. Under Rule II many permits have been issued to legitimize certain uses in forest lands, such as hunting wild game, which it was believed could be granted with due regard for the main purpose for which the reserves were created. The only arrests under our regulations were made by the police in February and March, 1918, when two men were apprehended for trespassing on the watershed in Nuuanu Valley in violation of Rule III. Each was fined $10 and costs.

PROTECTION OF BIRD LIFE.

Owing to depredations committed on certain small islands off the windward coast of Oahu, in which wild sea birds were killed for their feathers and their nests robbed of eggs, the 1917 Legislature passed Act 214 which gave this Board power to promulgate and enforce all necessary rules and regulations for the protection of bird, animal and vegetable life on the islands of Moku Manu, Moku Lua, Popoia, Manana, Kaohikaipu, Mokuhooniki and Kapapa. This Board accordingly on July 20, 1917, passed Rule IV of the Division of Forestry which was approved by the Governor on July 28, 1917, and went into effect immediately.

DIVISION OF FORESTRY.

RULE IV.

The Board of Commissioners of Agriculture and Forestry hereby make the following rule and regulation for the protection of bird, animal and vegetable life on certain islands of the Territory of Hawaii.

Section 1. It is unlawful for any person to hunt, trap, capture, wilfully disturb or kill any bird or any animal of any kind whatever, or to take, injure or destroy the eggs of any bird, or to cut, chop, burn, injure or destroy any vegetation on the islands of Moku Manu, Moku Lua, Popoia, Manana, Kaohikaipu, Mokuhooniki and Kapapa, except as authorized by written permit from the Superintendent of Forestry.

Section 2. The going on or being on said islands with intent to destroy, molest, disturb, or injure any bird, animal or vegetable life thereon without a written permit from the Superintendent of Forestry is forbidden and declared to constitute trespass punishable by fine.

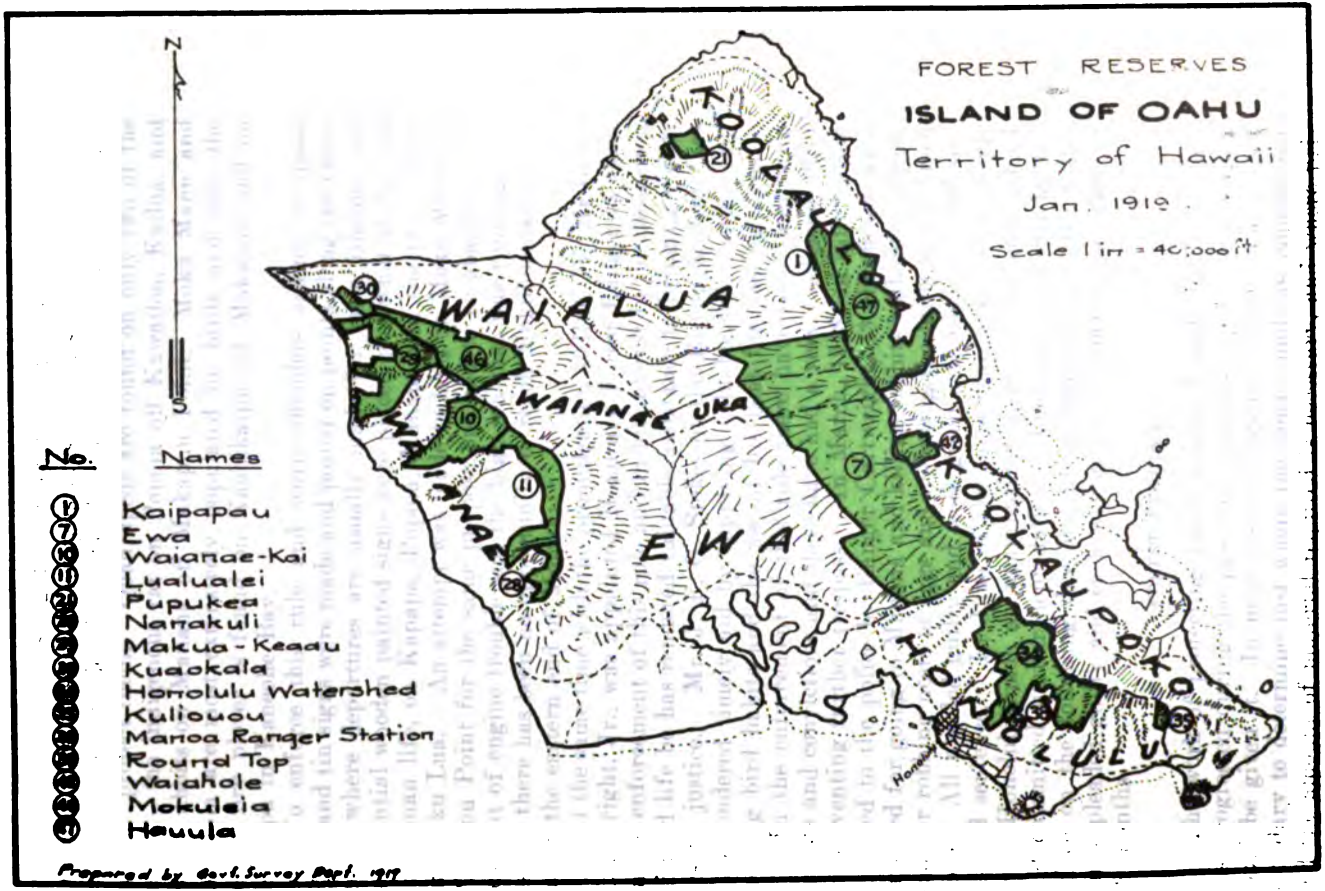
Section 3. Any person violating the above rule shall be guilty of a misdemeanor and upon conviction thereof shall be punished by a fine not to exceed Five Hundred Dollars ($500.00), as provided by Section 529, Revised Laws of Hawaii of 1915.

This rule shall take effect upon its approval by the Governor of Hawaii.

Approved this 28th day of July, 1917.

LUCIUS E. PINKHAM,
Governor of Hawaii.

Honolulu, Territory of Hawaii.


FOREST RESERVES
ISLAND OF OAHU
Territory of Hawaii
Jan. 1919
Scale 1 in = 40,000 ft
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No.
Names
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㉑
Kaipapau
Ewa
Waianae-Kai
Lualualei
Pupukea
Nanakuli
Makua-Keaau
Kuaokala
Honolulu Watershed
Kuliouou
Manoa Ranger Station
Round Top
Waiahole
Mokuleia
Hauula
WAIALUA
WAIANAE UKA
WAIANAE
EWA
KOOLAULOA
KOOLAUPOKO
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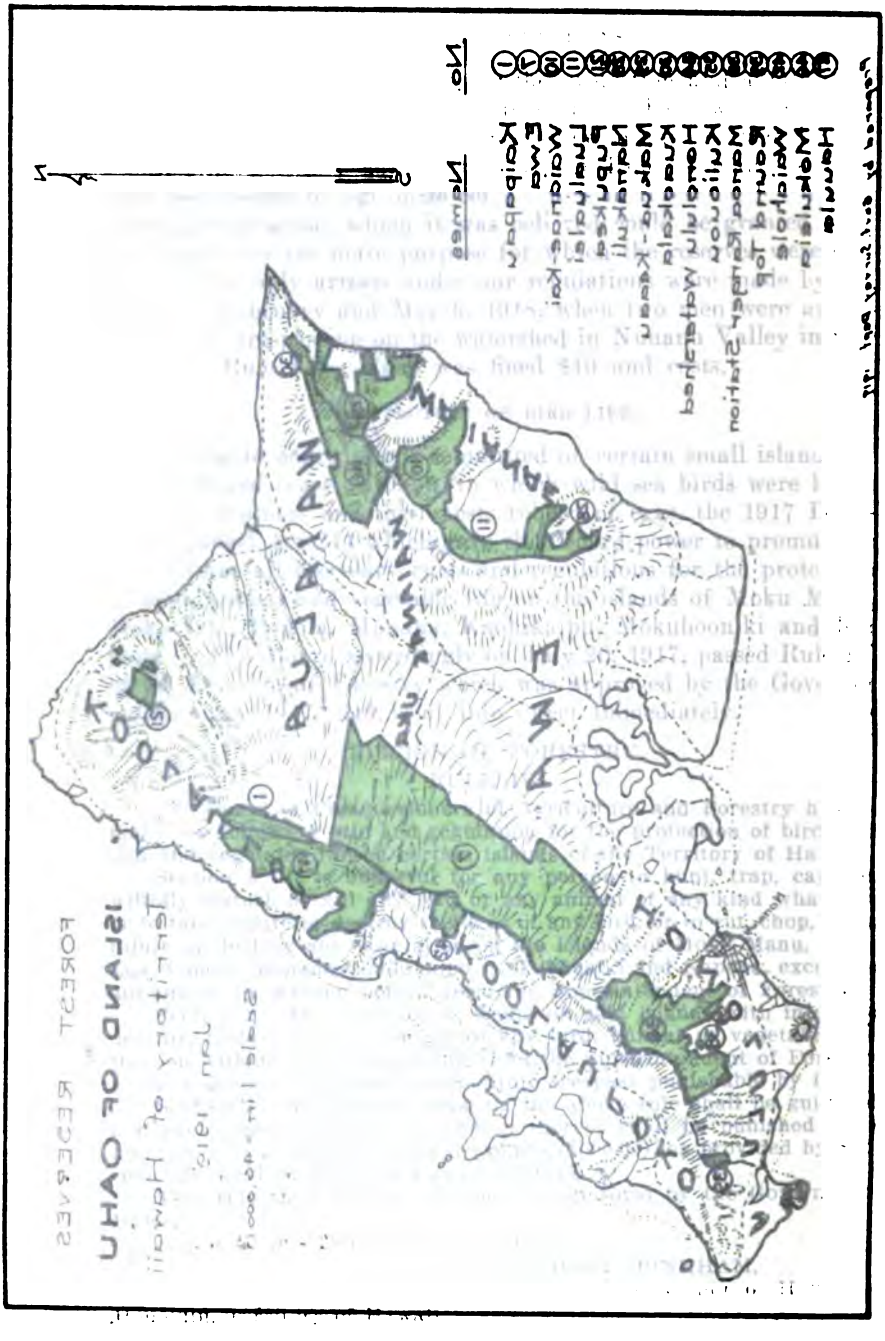
Prepared by Govt. Survey Dept. 1917


FOREST RESERVES
ISLAND OF OAHU
Territory of Hawaii
Jan. 1918
Scale 1 inch = 40,000 ft.
No. Name
1 Kaipapau
2 Ewa
3 Waianae-Kai
4 Lualualei
5 Pupukea
6 Nanakuli
7 Makua-Keaau
8 Kuaokala
9 Honolulu Watershed
10 Kuliouou
11 Manoa Ranger Station
12 Round Top
13 Waiahole
14 Mokuleia
15 Hauula
KOOLAU
WAIANAE
N

The birds consisting largely of the petrel. and frigate bird which nest on these small rocky islands are sea scavengers and may therefore be considered beneficial, and for this reason it is desirable to protect them. Quadrupeds are found on only two of the islands, the indigenous rat on Popoia off Kawailoa, Kailua, and wild rabbits on Manana off Makapuu Point. Moku Manu and Manana are most extensively populated by birds and only the migratory plover is found on Kaohikaipu off Makapuu and on Kapapa in Kaneohe Bay.

To enforce this rule and warn offenders against trespass, cloth and tin signs were made and posted on points along the Oahu coast where departures are usually made for these islands, and substantial wooden painted signs were placed somewhat at the risk of human life, on Kapapa, Popoia, Manana and the two islands of Moku Lua. An attempt was made to land on Moku Manu off Mokapu Point for the same purpose but had to be abandoned on account of engine trouble and the high sea that was running, and as yet there has been no opportunity to reach Mokuhooniki, which is off the eastern end of Molokai.

At the same time with the promulgation of Rule IV. Mr Bruce Cartwright, Jr., was appointed Honorary Forest Ranger to assist in the enforcement of this rule and in his interest in the protection of bird life he has rendered valuable assistance in bringing violators to justice. Mr. J. F. G. Stokes of the Bishop Museum has also rendered timely aid by supplying valuable information concerning bird habits and the use of his boat for posting signs.

In the enforcement of this rule there have been twenty-two arrests and convictions and these have had a very wholesome effect in preventing further trespass. In March, 1918, on information supplied to the police by Ranger Cartwright, 13 chauffeurs were arrested for going to Manana and killing rabbits without a permit and for robbing nests of eggs and molesting the birds which breed there. All pleaded guilty and were given a thirteen months' suspended sentence. In June of the same year, nine other people from Honolulu made an unauthorized visit to the same island and committed similar depredations. They were arrested by the police on the following day and upon appearance in the police court pleaded guilty and each was given a suspended sentence of 13 months.

FOREST FENCING.

The work of protecting forest reserve boundaries by fencing has progressed during the past two years as rapidly as attention could be given it. In most cases a personal examination of the boundary to determine just where the fence should be constructed and the amount of material required is necessary, and where pri-

vate land is involved negotiations must be made with the owner for cooperative fencing. Owing to the nature of the land short stretches of fence across a valley or over a ridge will protect large areas further back on the mountains and so far as possible the lines of new forest reserve boundaries have been laid out so that natural barriers, impassable to stock, are taken advantage of. In addition to the construction of new fences, attention has been given as well to the repairing of existing fences, for in this manner stock can effectively be kept out of a forest at comparatively small expense and a fence is not worth much unless it is stockproof.

The anthrax outbreaks which required my personal attention for several months during 1917 interfered somewhat with the fencing program. Many of the boundaries to be fenced are situated in out of the way places where it is hard to transport the posts and wire and where labor is scarce and hard to obtain, but it was found possible through the efforts of this Division and cooperation with private owners and the Land Office to construct during the biennial period 14.42 miles of new fence and repair 4.21 miles of existing fences on forest reserve boundaries, making a total of 18.63 miles of boundary adequately protected by the necessary stockproof fences.

The fencing work in detail during the past two years was as follows:

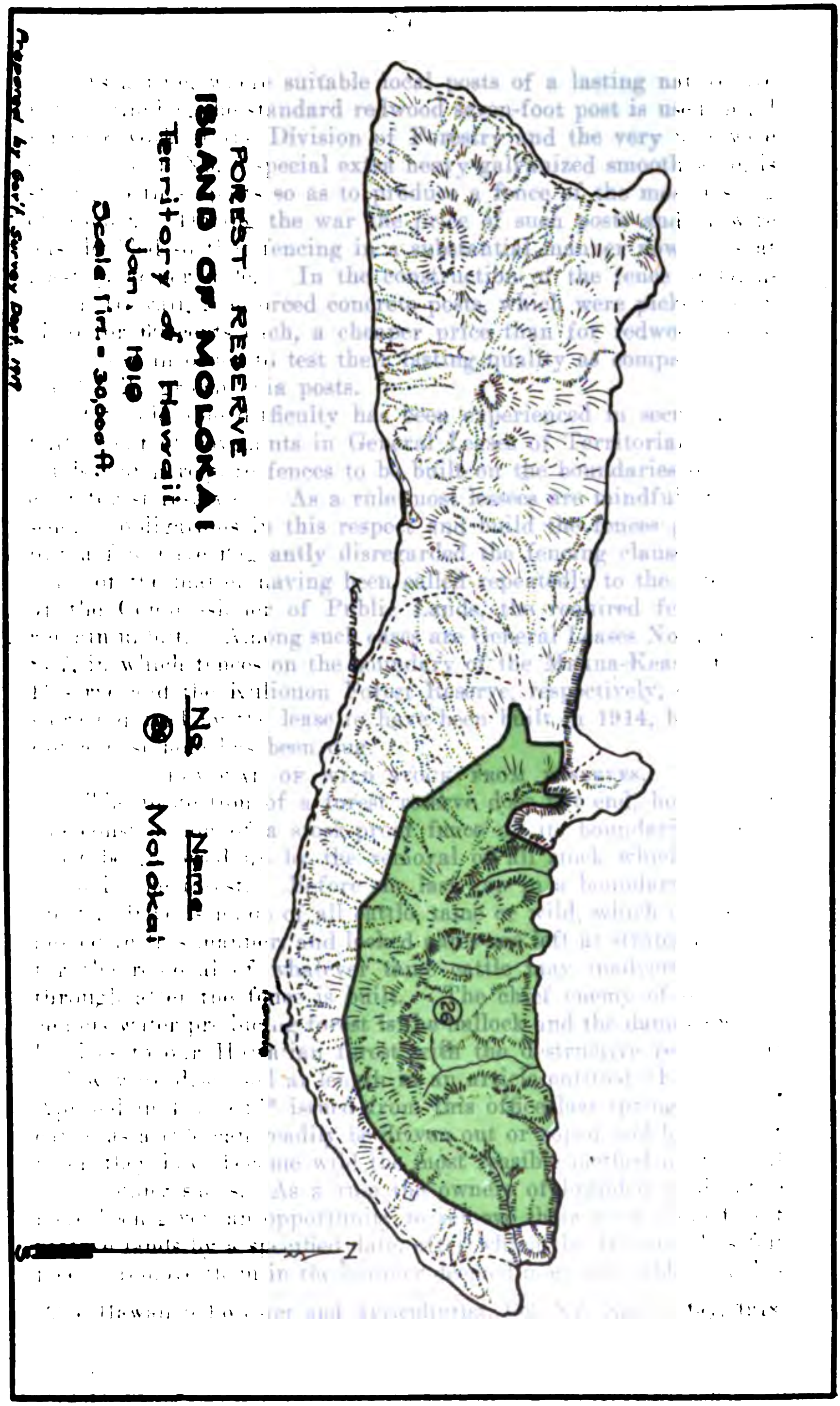
FENCES CONSTRUCTED, 1917-1918.

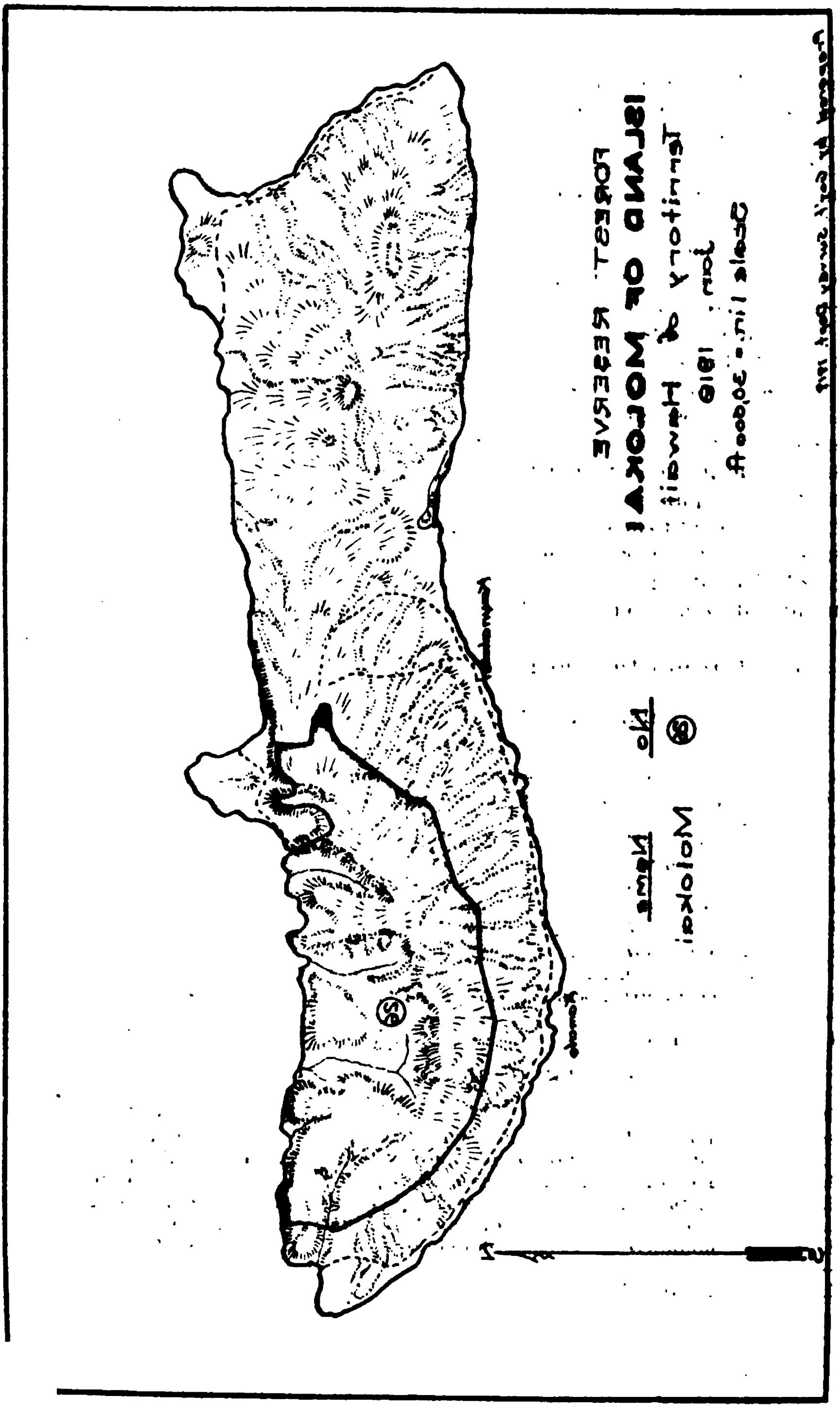
Date Completed.	Island.	Reserve.	Location	Length (miles)
May, 1917	Oahu	Honolulu Watershed	Makiki	.08
Sept., 1917	Hawaii	Olaa Forest Park	Olaa	.48
Nov., 1917	Oahu	Nanakuli	Nanakuli	1.35
Dec., 1917	Hawaii	Hilo	Laupahoehoe	2.78
May, 1918	Hawaii	Hilo	Piha	3.42
July, 1918	Oahu	Waianae-kai	Waianae	.22
Aug., 1918	Maui	Makawao	Makawao	.89
Sept., 1918	Oahu	Waiahole	Waiahole	.59
Sept., 1918	Oahu	Hauula	Hauula	1.05
Dec., 1918	Hawaii	Olaa Forest Park	Glenwood	3.56
			Total	14.42

FENCES REPAIRED, 1917-1918.

Date Completed.	Island.	Reserve.	Location	Length (miles)
April, 1917	Oahu	Honolulu Watershed	Nuuanu	.37
June, 1918	Oahu	Pupukea	Pupukea	1.19
Aug., 1918	Maui	Makawao	Makawao	.53
Nov., 1918	Maui	Makawao	Olinda	1.31
Dec., 1918	Oahu	Waiahole	Waiahole	.81
			Total	4.21

Biennial Report, 1918, Board of Agriculture and Forestry. **Map III.**




FOREST RESERVE
ISLAND OF MOLOKAI
Territory of Hawaii
Jan. 1918
Scale 1 in. = 30,000 ft.
No
Name
㉙
Molokai
Prepared by Gov't Survey Dept. 1917
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As a rule, where suitable local posts of a lasting nature are not obtainable, the standard redwood seven-foot post is used in all fencing work of the Division of Forestry and the very best wire obtainable, a No. 6 special extra heavy galvanized smooth wire, is strung to these posts so as to produce a fence of the most lasting character. During the war the price of such posts and of wire has doubled so that fencing in a substantial manner now costs at least $500 per mile. In the construction of the fence at Glenwood, Hawaii, reenforced concrete posts, which were picked up in Hilo for 60 cents each, a cheaper price than for redwood posts, were used in order to test their lasting quality as compared with the locally grown ohia posts.

Considerable difficulty has been experienced in securing the fulfillment of covenants in General Leases of Territorial grazing lands which require fences to be built on the boundaries of adjacent forest reserves. As a rule most lessees are mindful of their solemn obligations in this respect and build the fences promptly, but a few have flagrantly disregarded the fencing clause and, in spite of the matter having been called repeatedly to the attention of the Commissioner of Public Lands, the required fences still remain unbilt. Among such cases are General Leases No. 730 and 837, in which fences on the boundary of the Makua-Keaau Forest Reserve and the Kuliouou Forest Reserve, respectively, on Oahu, were required by the lease to have been built in 1914, but as yet not a post hole has been dug.

REMOVAL OF WILD STOCK FROM RESERVES.

The protection of a forest reserve does not end, however, in the construction of a stock-proof fence on its boundaries. This must be followed up by the removal of all stock which still remain in the forest. Before the last gap in a boundary fence is built a drive is made of all cattle, tame or wild, which can be removed in this manner, and locked gates are left at strategic points for the removal of whatever tame cattle may inadvertently get through after the fence is built. The chief enemy of our indigenous water-producing forest is the bullock and the damage which he does to our Hawaiian forest with the destructive results that follow were discussed at length in an article entitled "Forestry as Applied in Hawaii"* issued from this office last spring. Tame cattle as a rule can readily be driven out or roped and led out but when they have become wild the most feasible method of removal is in gunny sacks. As a rule the owners of branded wild cattle have been given an opportunity to remove their stock from forest reserve lands by a specified date, after which the Division has felt free to remove them in the manner deemed most advisable. In this way a considerable amount of wild stock has been eliminated from forest reserves. Where the owner of branded wild cattle is unknown, or cannot be located, more difficulty may be encountered and legislation to authorize the killing of such cattle, without compensation, but after published notice, is desirable.

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*The Hawaiian Forester and Agriculturist, Vol. XV, No. 5, May, 1918.

Since the hunting of wild animals on a forest reserve, except as authorized by permit from the Superintendent of Forestry, by Rule II constitutes trespass punishable by a fine, permits have readily been issued to responsible parties to shoot cattle, when the way is clear, and pigs and goats in the reserves on the several islands. Complete returns on the number of wild animals killed in this manner are not obtainable but from the reports which have reached this office through the rangers and otherwise, it is certain that during the past two years at least 129 wild cattle, 397 wild pigs and 141 wild goats (exclusive of Kahoolawe) have been shot or killed on or removed from government lands in forest reserves on Kauai, Oahu, and Hawaii. A condition is included in each permit requiring that as full use as possible be made of the meat of such animals, and in this manner the forest reserves have helped out considerably in the food supply.

FOREST FIRES.

During the past two years, in spite of some unfavorable weather conditions, we were fortunate in having no serious forest fires which did any extensive damage, and only a few grass fires, the dates and localities of which were as follows:

June 25, 1917.—Ewa Forest Reserve, Oahu. A fire which started from smoking out a bee tree spread at 11 a.m. on the military reservation of Waianae-uka on the South Fork of the Kaukonahua River and burned over about 50 acres of grass land and ferns with a few clumps of trees before it was gotten under control by nightfall through the efforts of two troops of the Fourth Cavalry and 90 prisoners of war.

August 19, 1917.—Maili Ridge, Oahu. A small grass fire started on the Leilehua plateau, but was extinguished the same day by U. S. troops.

August 28, 1917.—Piihonua, near Hilo, Hawaii. A fire escaped from a Hawaiian burning brush and burned over about 50 acres of open and scrub forest land. Laborers from nearby plantations under the direction of Fire Warden John A. Scott succeeded in getting the fire under control after a few days' work.

September 16, 1917.—Waikapu Valley, Maui. A fire burned over 10 acres of waste land covered with pili grass and lantana, but was extinguished in a few hours.

Plate 3.

Popoia, One of the Small Bird Islands off Oahu Protected by Rule IV.

November 9, 1918.—Ewa Forest Reserve, Oahu. A grass and brush fire occurred from causes unknown on the same area on the military reservation as the fire of June 25, 1917. About 25 acres were burned over before it was extinguished in two hours by a troop of cavalry assisted by a shower of rain.

During the dry period of 1917 new cloth fire warning notices were printed and distributed to the District Fire Wardens, who posted them at conspicuous points where fires were apt to occur.

In August, 1917, the menace of homesteaders' clearing fires and the dry condition of the woods at Laupahoehoe, Hawaii, made it advisable to appoint Mr. H. S. Rickard as Assistant Fire Warden and he rendered valuable services in preventing many small forest fires in this region. A number of new Fire Wardens were appointed throughout the Territory to take the place of those who had either died, resigned, or moved away from their districts.

A revised list of District Fire Wardens, together with the District Foresters, who look out for the interests of forestry in general, is presented at the end of this report.

FOREST EXTENSION.

The official setting apart of forest reserves, the fencing of their boundaries where necessary, and the elimination of stock must be followed up with the reestablishment of the forest cover by artificial means wherever it has been so badly depleted that it will not come back naturally. This is accomplished by planting trees. In this work the native koa and other indigenous trees have largely been used, but attempts have been made as well to obtain new species which will be suitable for covering our watersheds.

TREE INTRODUCTION.

We must naturally turn to all parts of the tropical world for new species, and a variety of new trees have been introduced by the Division during the past two years not only to determine which are suitable as watershed cover to supplement our native forest but which will produce valuable timber on areas where water conservation is not a factor. In this work of tree introduction Consulting Botanist Mr. J. F. Rock has been of material assistance. In April, 1917, 37 trees of 20 different species of trees which he brought from the Philippines were planted out on Tantalus in order that they might serve as a future source of seed for distribution throughout the Territory. These are important timber trees of the Philippine Islands which are profuse seeders and which probably will be suitable for watershed protection. They were permanently staked out and tagged so as to retain their identity. The

Consulting Botanist also supplied this Division with a quantity of seed of the Sau Tree, *Albizzia moluccana* from British North Borneo. This is a very rapidly growing tree which is already showing up very well with us.

Experiments with the growing of the Benguet pine, *Pinus insularis*, which we have raised from seed sent to us by the Director of Forestry at Manila, P.I., have proved that it will not grow to any size at our lower levels, but does very well at elevations of 6,000 feet on Hawaii. The seed of the Molave, *Vitex parviflora* which he has also sent have germinated well, and show good promise of succeeding here.

The Australian red cedars, *Cedrela australis*, introduced in 1916 and distributed to 22 different places in the islands, are doing remarkably well and in some localities have grown at the rapid rate of 11 feet in 15 months.

In August 1917, 39 different species of eucalypts, acacias, and other Australian trees raised from seed secured by Mrs. C. C. Kennedy and kindly presented to this Division were planted out on the Manoa Ranger Station to test their adaptability to the region.

During the same month two boxes of New Zealand trees were received from Hon. E. Mitchelson of Auckland and a part were set out on the Manoa Ranger Station. Among these are the kauri pine, rimu or red pine, *Dacrydium cupressinum*, and other important trees of New Zealand.

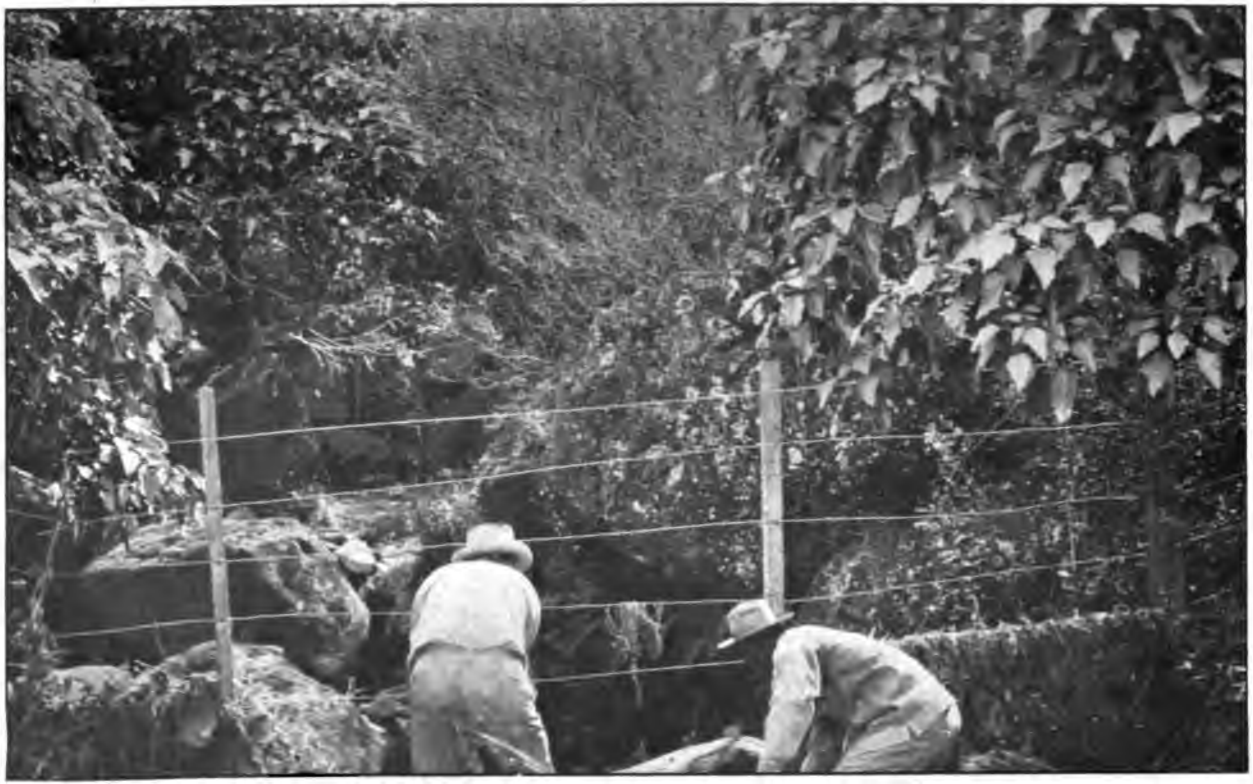
From trees growing in Honolulu we have obtained seed of the gum arabic, *Acacia arabica* and khair, *Acacia catechu*, and have raised young trees for distribution. These are two valuable Indian trees which are suitable for planting in the drier parts of these islands. Seedlings of the logwood have been similarly handled.

A supply of seed of the karaka tree, *Corynocarpus laevigata* was secured from the 1918 crop at Halemanu, Kauai, and distributed to forest rangers and inhabitants of the higher elevations on Maui and Hawaii for planting. Several pounds were also donated to the H. S. P. A. for use in their new forestry operations.

TREE PROPAGATION AND DISTRIBUTION.

The nurseries for the propagation and distribution of trees have continued to be maintained at Honolulu, Homestead, Kauai, and Hilo, Hawaii, and have done good service in supplying homesteaders, agriculturists, inhabitants of army posts, ranchers, and plantations throughout the Territory with forest, shade and ornamental trees. The total number of trees so distributed fell about a quarter of a million short of the number sent out during the previous two years but amounted to 651,411 trees. Shortage of labor for tree planting operations partly accounted for this de-

Plate 4.



Repairing Forest Reserve Boundary Fence at Lualualei, Oahu.

crease. Further details of this work are given in the report of the Forest Nurseryman.

ARBOR DAY.

Arbor Day as usual was celebrated in 1917 on November 16 and in 1918 on November 22. This is participated in mostly by school children whom we have attempted to assist in the beautification of their school grounds not only by furnishing them with trees for planting free of cost but also with advice as to their care and protection.

The numbers of trees distributed from the government nurseries for planting on Arbor Day during the last two years were as follows:

Nurseries	1917	1918	Total
Government Nursery, Honolulu	10,490	10,500	20,990
Sub-Nursery, Homestead, Kauai	1,287	1,125	2,412
Sub-nursery, Hilo, Hawaii	334	339	673
Total	12,111	11,964	24,075

This distribution is about 5,000 trees less each year than the average annual tree distribution during the past twelve years.

NEW FOREST NURSERY.

During July 1918, as a step in the extension of tree planting work on the forest reserves, a new nursery was established in the Lualualei Forest Reserve on the west slope of the Waianae Mountains, Oahu, just below Kolekole Pass. A small house for the accommodation of laborers was constructed and water was piped to the house and nursery terraces from the nearby perennial stream. Most of the seedlings are started in the Makiki Nursery and shipped down in seed boxes to this new nursery where they are transplanted and held until of sufficient size for planting out. The planting gang of Hawaiian laborers which in May 1918 had completed the reforestation of all open government forest reserve lands in Manoa Valley was shifted to this new locality where the forest cover should be reestablished because of the benefit which it will exert on the valuable springs and small streams in this comparatively dry region. This site was also selected because of the opportunity which it presents for testing out the trees which are best suited to the drier situations in these islands and for obtaining knowledge and experience along this line which at present are lacking.

A similar expansion of reforestation work is desirable at other places in the islands and it is hoped that sufficient funds will be available to permit the establishment of new nurseries with their accompaniment of tree planters on the Kula Forest Reserve, Maui, the Mokuleia Reserve, Oahu, and at Piihonua on the Hilo Watershed, Hawaii.

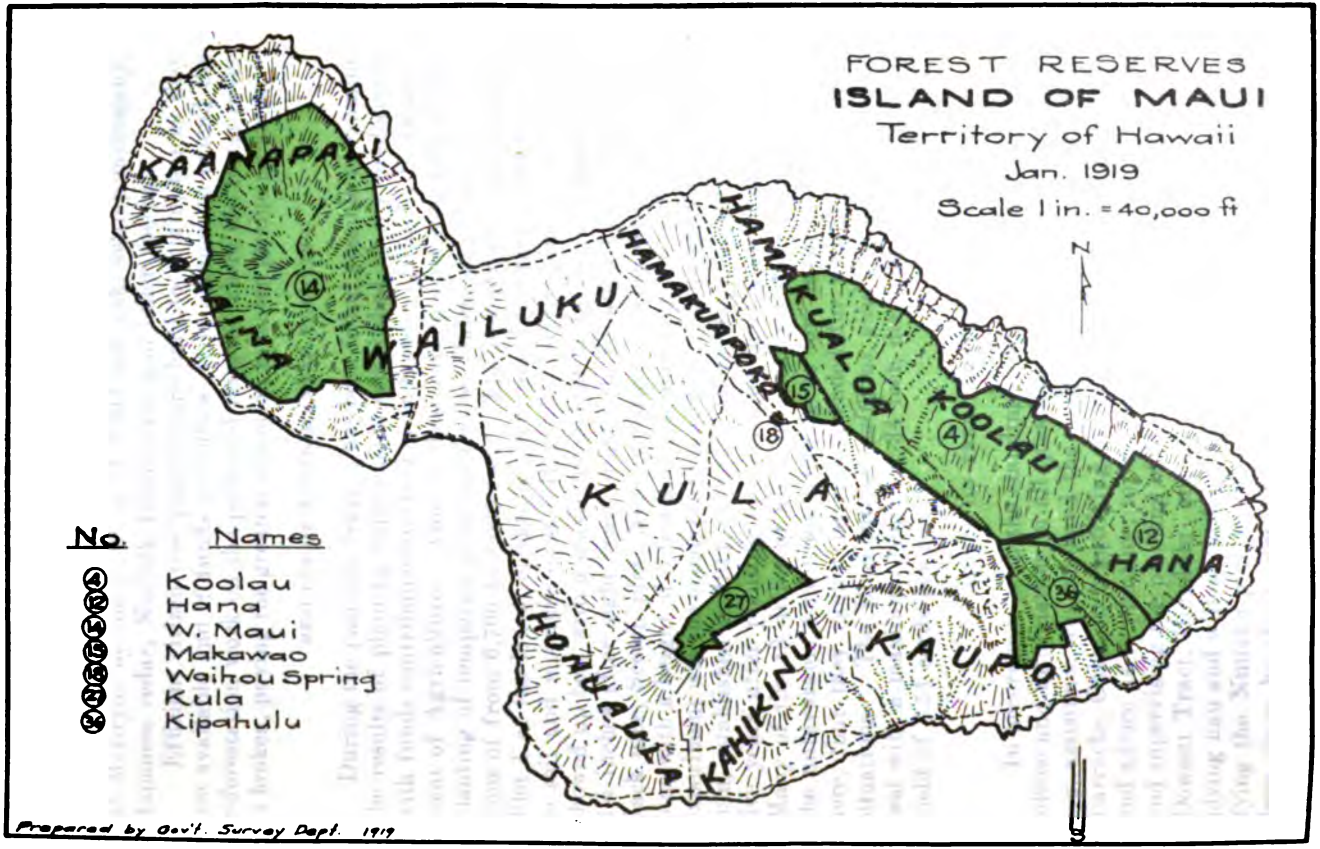
TREE PLANTING ON FOREST RESERVES.

The tree planting work done by the Division of Forestry during the past two years has been confined almost wholly to watershed areas and particularly to the water-producing region back of Honolulu, for it is only from a completely forested watershed that the best results in the way of an even and continuous flow of water can be obtained. The operations of the Division have extended over five different regions and a total of 44,444 trees have been planted and cared for on forest reserves at Makiki and Tantalus, Manoa, and Lualualei on Oahu and at the Papapaholahola Spring and Kamalomaloo on Kauai. In this planting, in addition to the miscellaneous species listed below, a total of 21,138 koa trees were set out. This native tree is used in the belief that it is quite suited to planting on situations where there is a well drained soil and that it forms a good cover since it allows native shrubs and ferns to come up in its shade. The koa responds readily to nursery treatment and the only difficulty which we have had is the inability to secure seed in large quantities because of an insect which riddles the pods before the seed is even ripe.

On the Honolulu Watershed Forest Reserve, Oahu, the reforestation of the open places in the Makiki Valleys, begun in 1913, was continued by the planting out of 8,796 koa on the slopes and 3,304 trees of various species at the lower ends of the valley bottoms. Among the latter were 1,484 mahogany and 686 yellow poinciana trees which were planted 8 by 8 feet apart in December, 1917, and May, 1918, respectively, to test their growth under close planting conditions. The koa trees which were first planted on Sugar Loaf are now five years old and constitute a healthy forest with a complete crown canopy. On this same reserve all of the open government lands in Manoa Valley were reforested in the sixteen months ended May, 1918. On approximately 63 acres there were set out 8,516 koa trees and 5,011 trees of other species among which were Australian tea trees, papala kepau, African tulip, banyan, Australian red cedar, sau tree, Japanese cedar, silk oak, Cook pine and Benguet pine.

On the Lualualei Forest Reserve, Oahu, the planting which began in July, 1918, included a total of 5,304 trees among which were 3,826 koa and the following dry region trees: wiliwili, gum arabic, black locust, yellow poinciana, kassod and logwood. On a part of the Pupukea Forest Reserve, Oahu, 2,934 trees of various species were set out under contract in December, 1918, on water Reserve A. by Libby, McNeill & Libby on land which had formerly been cultivated in pineapples.

On Kauai, the planting work was continued on the Kealia Reserve by Ranger Lovell by the setting out of 5,232 trees consist-


FOREST RESERVES
ISLAND OF MAUI
Territory of Hawaii
Jan. 1919
Scale 1 in. = 40,000 ft
N
KAANAPALI
LAHAINA
WAILUKU
HAMAKUAPOKO
HAMAKUALOA
KOOLAU
KULA
HANA
KAUPO
KAHIKINUI
HONUAULA
⑭
⑮
⑱
④
⑫
㉗
㊱
No. Names
④ Koolau
⑫ Hana
⑭ W. Maui
⑮ Makawao
⑱ Waihou Spring
㉗ Kula
㊱ Kipahulu
Prepared by Gov't. Survey Dept. 1919

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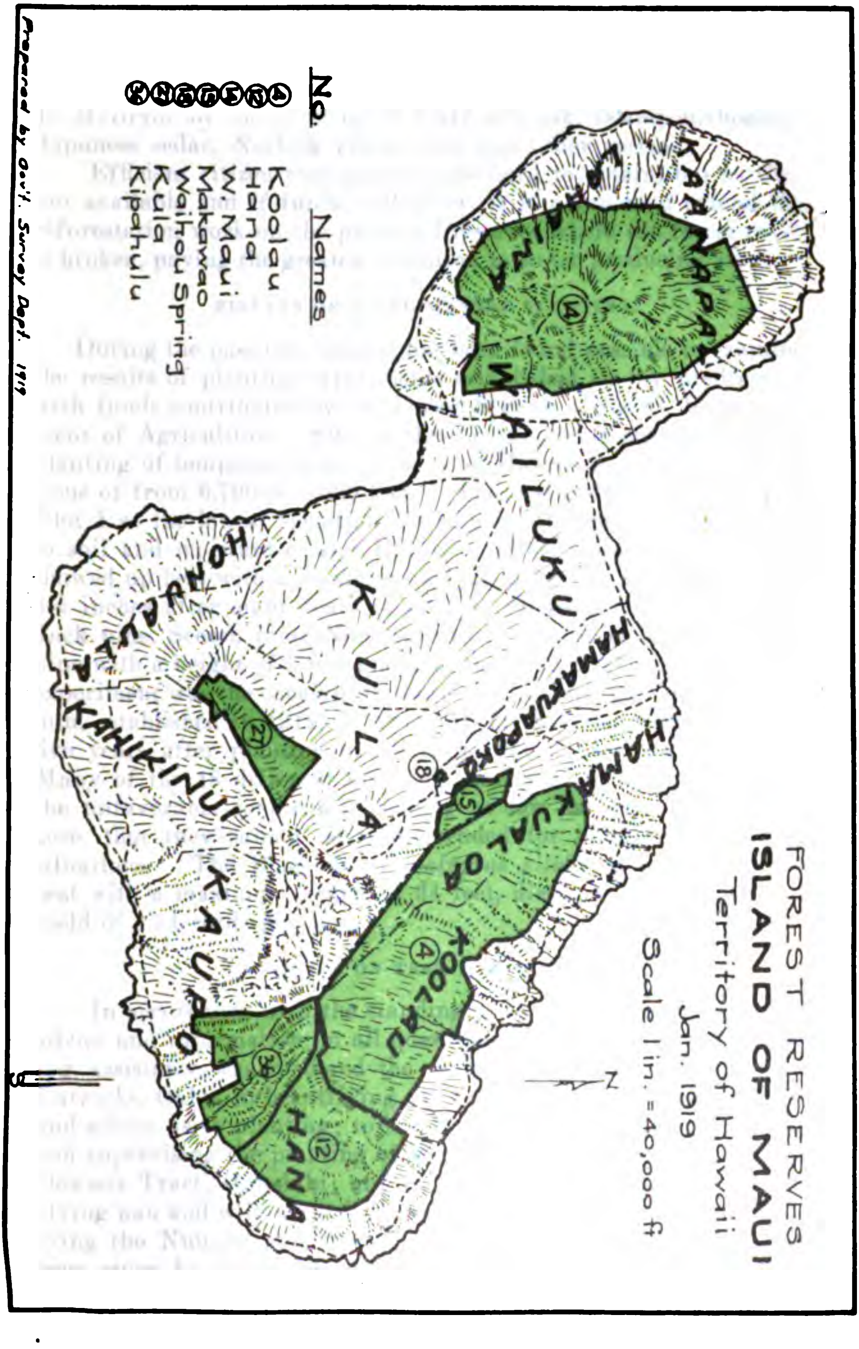


FOREST RESERVES
ISLAND OF MAUI
Territory of Hawaii
Jan. 1919
Scale 1 in. = 40,000 ft

Prepared by Gov't. Survey Dept. 1919

ing of silk oak, swamp mahogany, lemon gum, ironwood, and Japanese cedar and on the Papapaholahola Spring Reserve near Kalaheo by two laborers working under the direction of Mr. W. D. McBryde by the planting of 5,347 silk oak, swamp mahogany, Japanese cedar, Norfolk Island pine and other species.

Efficient citizen tree planters are hard to obtain, but as they are available and if funds will allow, it is planned to extend the reforestation work on the protected reserves where the forest cover is broken, paying the greatest attention to water producing areas.

RESULTS OF EXPERIMENTAL PLANTING.

During the past two years it has been found possible to examine the results of planting experiments established by my predecessor with funds contributed by the Forest Service of the U. S. Department of Agriculture. One of these experiments consisted of the planting of temperate zone conifers on Haleakala, Maui, at elevations of from 6,700 to 9,000 feet. The best growth was found in Plot I at the lowest elevation where more favorable conditions as to soil and moisture exist. Here the Jeffrey pine of California showed up best with a maximum height of 11 feet and diameter of 3½ inches after eight years of growth, followed by Coulter pine, Jack pine, Scotch pine, Norway spruce, incense cedar, and white pine with a height of 5 feet and a diameter of one inch. The other experiment was the eucalyptus plantation in Nuuanu Valley, Honolulu, established in 1911, in which all of the trees were measured five years after planting to determine their growth and volume. Many of the 18 different kinds of eucalypts did so poorly under the unfavorable conditions, yielding as low as only .12 cord per acre, that they cannot be recommended for planting in similar situations. The Blackbutt, *Eucalyptus pilularis,* showed up the best with a maximum height of 34 feet, diameter of 6 inches and yield of 4.51 cords per acre.

ADVICE ON TREE PLANTING.

In accordance with the standing offer of the Division to give advice and information on all questions connected with tree planting, assistance was rendered the commanding officer at Schofield Barracks, Oahu, in beautifying the reservation by furnishing trees and advice as to planting; to the Dowsett Company in furnishing and supervising the planting of koa trees on the new streets in the Dowsett Tract, Honolulu; and to the Oahu Country Club in supplying hau and willow cuttings, and koa and other trees for beautifying the Nuuanu golf links. Advice in tree planting has also been given by the Forest Nurseryman to many others who have called upon this Division for assistance.

TREE PLANTING ON PRIVATE LANDS.

In order to keep track of the general progress of forestry in the Territory reply post cards are sent out each year to all tree planters with the request that they return the number and species of trees planted and the purpose of planting. These figures, while not complete, because all tree planters cannot be reached, are analyzed and the results published every two years. For the biennial period just ended the total number of trees planted, as shown in the list which follows, was 1,632,598. This is only 171,130 trees short of the number planted in 1915 and 1916.

NUMBER OF TREES PLANTED IN THE TERRITORY OF HAWAII in 1917 and 1918.

KAUAI.

	1917	1918	Total
Gay and Robinson	1,500	3,205	4,705
Grove Farm Plantation	20,000	21,500	41,500
Hawaiian Sugar Co.	40,000	20,000	60,000
Isenberg, Rev. Hans	50		50
Kekaha Sugar Co.	505		505
Kilauea Sugar Plantation Co.	11,250	5,500	16,750
Knudsen Bros.	6,300	40,200	46,500
Lihue Ranch	4,278		4,278
Makee Sugar Co.	10,543	8,250	18,793
McBryde Sugar Co.	9,459	4,593	14,052
Territory of Hawaii	6,784	3,795	10,579
	110,669	107,043	217,712

OAHU.

	1917	1918	Total
Cooke, Mrs. C. M.	300	1,230	1,530
Dowsett Company	381		381
Ewa Plantation Co.		247	247
Hawaiian Pineapple Co.	4,000	9,000	13,000
Hawaii Preserving Co.	6,000	3,000	9,000
Honolulu Plantation Co.	20,110		20,110
Judd, Mrs. A. H. B.	200		200
Kahuku Plantation Co.		5,000	5,000
Kemoo Farm	100		100
Koolau Agricultural Co.	500		500
Kunia Development Co.	500		500
Laie Plantation	1,154	300	1,454
Marconi Wireless Tel. Co.	600		600
Sandwich Islands Honey Co.	17,000	20,000	37,000
Territory of Hawaii	18,065	15,800	33,865
United States Army	5,500	6,994	12,494
Wahiawa Water Co.	15,200	1,000	16,200
Waialua Agricultural Co.	70,801	78,712	149,513
	160,411	141,283	301,694

MOLOKAI.

	1917	1918	Total
Baldwin Home	50		50

LANAI.

	1917	1918	Total
Lanai Company	1,912	406	2,318

MAUI.

	1917	1918	Total
Baldwin, Mrs. H. A.	1,600	650	2,250
East Maui Irrigation Co.	200		200
Grove Ranch	1,000		1,000
Haleakala Ranch	915	9,734	10,649
Hawaiian Comm. & Sugar Co.	1,400	1,000	2,400
Honolua Ranch	12,050	24,000	36,050
Krauss, Mr. F. G.	423	73	496
Maui Agricultural Co.	425,000	400,950	825,950
Pioneer Mill Co.	5,060	8,000	13,060
Wailuku Sugar Co.	10,700	20,923	31,623
	458,348	465,330	923,678

HAWAII.

	1917	1918	Total
Gamalielson, Mr. J. E.	52		52
Greenwell, Mr. F. R.	1,000		1,000
Hakalau Plantation Co.	542		542
Hamakua Mill Co.	32,260	15,000	47,260
Hawaiian Agricultural Co.	9,591	9,185	18,776
Hawaii Consolidated R. R.	100		100
Hawi Mill and Plantation Co.	5,875	1,660	7,535
Homesteaders		6,188	6,188
Honokaa Sugar Co.	10,000		10,000
Hutchinson Sugar Plantation Co.		740	740
Kaiwiki Sugar Co.	200		200
Kohala Sugar Co.	12,000	5,000	17,000
Niulii Mill and Plantation	1,200	3,000	4,200
Onomea Sugar Co.		500	500
Paauhau Sugar Plantation Co.	2,000	8,000	10,000
Pacific Sugar Mill	10,000		10,000
Parker Ranch	39,689	11,710	51,399
Puakea Plantation Co.	500	1,000	1,500
Vieira, Mr. J. S.	44		44
Waiakea Mill Co.	110		110
	125,163	61,983	187,146
Total for all islands	856,553	776,045	1,632,598

The leading species planted and the purpose of planting are given in the following table:

NUMBER OF TREES PLANTED IN THE TERRITORY OF HAWAII IN 1917 AND 1918 BY SPECIES AND PURPOSE OF PLANTING.

Purpose of Planting.

1917

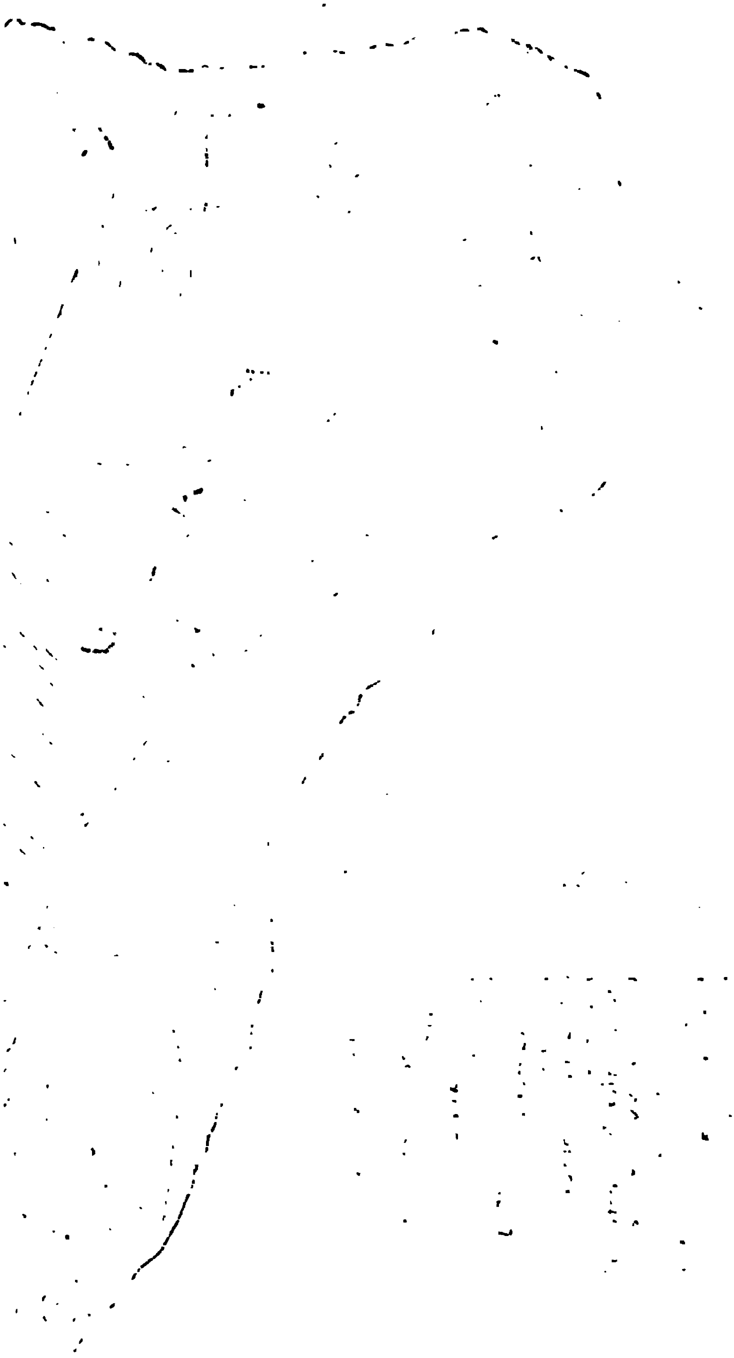
Species	Cover	Fuel	Windbreak	Ornament	Timber	Total
Swamp mahogany	385,743	79,519	8,081	25,600	900	499,843
Ironwood	....	60,604	53,900	20,520	....	135,024
Eucalptus spp.	....	26,116	44,604	....	15,000	85,720
Blue gum	....	42,000	3,000	450	2,500	47,950
Algaroba	....	20,590	....	....	....	20,590
Other spp.	2,547	....	60	7,514	5,557	15,678
Lemon gum	15,000	172	....	....	....	15,172
Silk oak	4,833	9,894	....	....	....	14,727
Koa	12,656	....	....	272	....	12,028
Japanese cedar	....	....	....	....	8,921	8,921
Totals	420,779	238,895	109,645	54,356	32,878	856,553

1918

Species	Cover	Fuel	Windbreak	Ornament	Timber	Total
Swamp mahogany	285,837	23,172	17,895	16,000	....	342,904
Blue gum	149,358	9,000	....	....	....	158,358
Ironwood	1,313	73,821	51,455	10,000	....	136,589
Red gum	13,800	38,515	18,794	....	....	71,109
Other spp.	6,676	....	1,000	24,327	....	32,003
Lemon gum	12,000	2,278	....	....	....	14,278
Koa	8,482	....	....	....	....	8,482
Eucalptus spp.	....	5,248	175	400	....	5,823
Silk oak	1,910	756	....	700	....	3,366
Algaroba	....	818	2,075	200	....	3,093
Japanese cedar	....	....	....	....	40	40
Totals	479,376	153,608	91,394	51,627	40	776,045

From the above it will be observed that the swamp mahogany, *Eucalyptus robusta,* is still the most popular tree for general planting and constitutes over 50 per cent of the total planted during the two years. The red gum, *Eucalyptus rostrata,* is said to withstand drought still better, however, and produces a more valuable wood, and is gaining in popularity with tree planters. Koa is also coming into greater prominence for planting on watersheds, the only difficulty being that good seed is hard to obtain on account of insect infestation.

During the previous two years, 44 per cent of the total number of trees planted were for the purpose of reestablishing a cover on watershed areas. That greater attention has lately been paid to reforestation for this purpose is evidenced by the fact that during the two years just ended the total number of trees planted on watershed areas constituted over 55 per cent of the total.



MISCELLANEOUS.

The other activities of the Division of Forestry have been given secondary consideration in view of the importance of the two main subjects described above. There is much investigative work of an important nature which should be undertaken and a considerable amount of desirable record work in the office which must be deferred until technical assistance is available or until time presents the opportunity.

COOPERATION WITH THE LAND OFFICE.

As during previous years, the Division of Forestry has continued to cooperate with the Commissioner of Public Lands in giving advice on technical forestry questions which come up in that office in connection with general leases and other matters and in reporting on the fulfillment of clauses concerning forestry in such leases. When a new lease of government grazing lands is made, fencing and other clauses requiring forest protection have been drafted for inclusion in the lease. Technical field assistance has also been rendered in prescribing and directing the thinning of algaroba trees under licenses issued by the Land Office which will increase the yield of honey, beans and wood.

During the fall of 1918, the Superintendent of Forestry accompanied the new Governor and the Commissioner of Public Lands on an official inspection of government lands on Kahoolawe, Hawaii, and Maui.

KAHOOLAWE.

Assistance was also given the Land Office in the preparation of clauses for inclusion in the new lease of the island of Kahoolawe which runs for 21 years from January 1, 1919. These clauses provide for the management of the island in such a manner that the goats will be exterminated during the first year and every encouragement will be given to the revegetation of the island by natural and artificial methods. As will be recalled, on April 20, 1918, after a public hearing, Kahoolawe was withdrawn from the forest reserve and returned to the jurisdiction of the Commissioner of Public Lands because under the old arrangement the complete extermination of the goats could not be accomplished, and the Board was not able by law to make a lease whereby sufficient inducements could be offered anyone to bring this about. Over 5,000 goats have been eradicated from the island during the eight years that it has been under the control of this Board and the algaroba has spread to such an extent that there is now a large annual crop of beans which should be utilized along with several thousand acres of good pili grass by restricted grazing. This the new lease allows, but only after the extermination of the goats, which must be accomplished during the first year. The whole purpose of the lease is to develop, conserve and improve the island rather than to exploit it.

KOKEE CAMPS.

A new departure for the Division was instituted during 1918, when at the expiration of a government lease, certain mountain meadow lands near the Kokee Stream and Halemanu on Kauai, within the Na Pali-Kona Forest Reserve, Kauai, at an elevation of 3,500 feet came under the jurisdiction of this Board. In response to requests from those who desired the privilege of camping out in this invigorating climate in the same manner that camping privileges are extended to many thousands on mainland National Forests, a total of 47 camping sites were surveyed out in the open areas along mountain streams and a form of permit which will safeguard the best interests of the forest and protect individual permittees was approved. These permits are for ten years and the annual charge for unimproved sites is based on the nominal rate of $10 per acre. The camp sites vary in size from .3 to 2.0 acres and are situated not far from the scenic beauties of Waimea Canyon, where the rainfall is not excessive and the nights are always cool. A good opportunity is presented here for those who desire a change from the lowlands in a cooler climate amidst pleasant surroundings. Kokee Camps are at present accessible over a passable automobile road which in all probability will be improved in the near future.

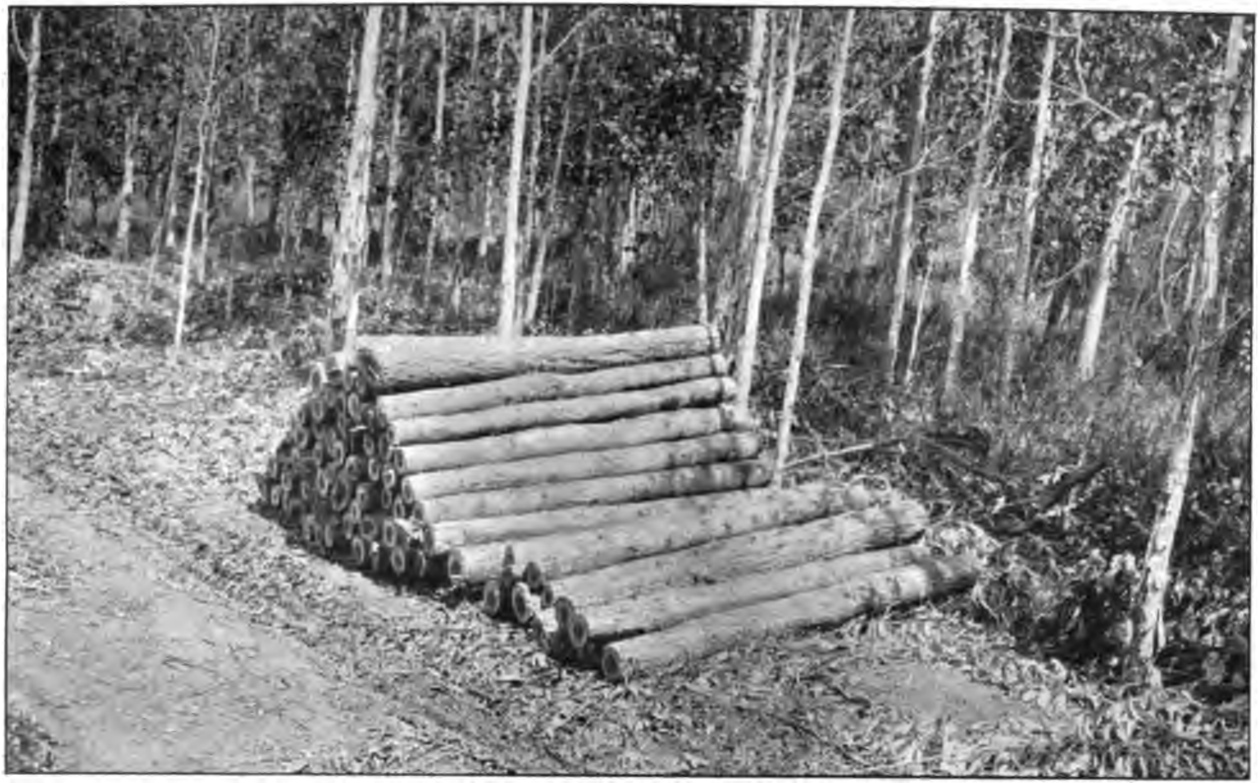
FIRST TERRITORIAL FAIR EXHIBIT.

Along with the other divisions of this Board, the Division of Forestry presented an exhibit at the First Territorial Fair, held at Kapiolani Park on June 10 to 15, 1918, which brought forth favorable comment from all who viewed it. In addition to the exhibits of young forest seedlings and transplants, native and introduced woods and bamboos, and maps showing forest reserves, a working erosion model was operated to show the beneficial effect of a forest cover on the runoff. By this model it was possible to bring home to the people in a very telling manner the lesson of the disastrous results of deforestation on watersheds and the valuable part which our native forest plays in the conservation of water and the importance of absolute forest protection in these islands.

PLANT PESTS.

Efforts have been made during the past two years to assist

Plate 5.



Durable Posts Cut from Eight Year Old Bloodwood Trees, *Eucalyptus corymbosa*, Grown in the Dry Land District, Waipio, Oahu

in the eradication of plant pests by destroying them on our own grounds and sending out warnings against their spread elsewhere. One of these, *Caesalpinia bonduc,* is a rambling climber with very sharp, hook-like spines, which upon invasion takes complete possession of everything within its reach. It has been in the islands for many years but fortunately is confined to a few localities. One of these was in Hering Valley in Makiki, but by persistent efforts in not only cutting and burning up all the plants and destroying the roots but also by destroying young seedlings which came up later, we have at last been able to eliminate it.

Another weed which spreads extensively and at an alarming rate is the Spiny Pig Weed, *Amaranthus spinosus.* As its name denotes, it bears a pair of very sharp thorns at the base of the leaves. Cattle will not eat the plant and shun the localities where it occurs. Upon detecting its unusually rapid spread in Manoa Valley attention to it was called in the May, 1917, "Hawaiian Forester and Agriculturist," with the advice that wherever found it be rooted out and burned before the seeds are ripe.

A new introduction, which it is hoped will not become established here, by the persistent efforts which have already been made to eradicate it, is the Morning Glory, or Bindweed, *Convolvulus arvensis,* which was discovered last fall on Maui. A warning against it was published in the November, 1918, "Hawaiian Planters' Record," and upon investigation by Ranger Lindsay it was found to be confined to two small patches along the Kahului Railway in Paia. This leads one to believe that it came in with hay or some other feed stuff. It is a troublesome weed on cultivated fields in the Atlantic States and California, and it would be very unfortunate if it became established here.

Chance introductions such as this are apt to occur in spite of all precautions but by exerting our best efforts in their eradication upon discovery and by apprising the people of the necessity of doing likewise it is believed that a great deal can be accomplished to prevent their establishment in these islands where we already have our share of plant pests.

PUBLICATIONS.

The following have been published by the Division of Forestry during the past two years in addition to the monthly and annual reports and special articles which have appeared in "The Hawaiian Forester and Agriculturist," the official monthly magazine of the Board:

April 6, 1917.	"Report of the Division of Forestry for the Biennial Period Ending December 31, 1916."
July 28, 1917.	Rule IV, Division of Forestry.
August, 1917.	Botanical Bulletin No. 4, "The Ohia Lehua Trees of Hawaii," by Joseph F. Rock, Consulting Botanist.
May, 1918.	"Forestry as Applied in Hawaii," by C. S. Judd, Superintendent of Forestry. Reprint from "The Hawaiian Forester and Agriculturist," Vol. XV, No. 5.

SUMMARY.

In conclusion, it is a pleasure to report that progress has been made in the two main activities of the Division, forest protection and forest extension. The work of examining, surveying, and setting aside the main forest reserve system has been concluded and the reserves which are shown on the maps printed with this report, now include 814,926 acres, 68 per cent. of which is government land. On the four main islands seven forest rangers are on duty protecting and administering government forest reserve lands and they have had a hand in the construction and repairing of 18.63 miles of reserve boundary fences and the elimination of much wild stock during the biennial period. Tree planters are gradually reforesting open areas in the reserves mainly in regions where water for city and domestic use is required. For the continuation of these lines of work an adequate appropriation for the coming biennial period will be greatly appreciated and more particularly for a few additional forest rangers, for more extensive fencing, and for the establishment of new forest nurseries accompanied by tree planting.

Respectfully submitted,

C. S. JUDD,
Superintendent of Forestry and Chief
Fire Warden.

LIST OF DISTRICT FIRE WARDENS

CHIEF FIRE WARDEN.

C. S. JUDD, Superintendent of Forestry, ex-officio.

DEPUTY FIRE WARDEN AT LARGE.

DAVID HAUGHS, in and for the Territory of Hawaii.

DISTRICT FIRE WARDENS.

KAUAI.

A. MENEFOGLIO, in and for Wainiha Valley, District of Halelea.
W. F. SANBORN, in and for the District of Halelea, excepting Wainiha Valley.
L. D. LARSEN.
GEORGE HUDDY, Assistant District Fire Warden. In and for the District of Koolau, excepting the land of Anahola.
E. M. CHEATHAM, In and for the portion of the Districts of Koolau and Puna, extending from the land of Anahola to the land of Olohena, inclusive.
C. H. WILCOX, In and for that portion of the District of Puna, south of and including the land of Wailua.
FRANK A. ALEXANDER, In and for that portion of the District of Kona, extending from the Hanapepe Valley to the Puna District line.
B. D. BALDWIN, In and for that portion of the District of Kona lying between and including the Waimea, Poomau, and Kauaikinana Valleys on the west and the Hanapepe Valley on the east.
ERIC A. KNUDSEN, In and for the District of Na Pali and that portion of the District of Kona, lying to the west of Waimea, Poomau, and Kauaikinana Valleys.

OAHU.

F. S. LYMAN, JR., In and for that portion of the District of Koolauloa from the Waialua District line to and including the land of Kaunala.
ANDREW ADAMS, In and for that portion of the District of Koolauloa lying to the north and east of the land of Kaunala.
W. H. CLEGHORN, In and for that portion of the District of Koolaupoko, extending from the Koolauloa District line to the land of Heeia.
WM. HENRY, In and for that portion of the District of Koolaupoko, extending from and including the land of Heeia to the land of Kailua.
JOHN HERD, In and for that portion of the District of Koolaupoko, extending from and including the land of Kailua to Makapuu Point.
CHARLES H. BAILEY, In and for that portion of the District of Kona, extending from Makapuu Point to Palolo Valley.
JOSEPH K. KAPONO, In and for Palolo Valley, District of Kona.
C. MONTAGUE COOKE, In and for Manoa Valley, District of Kona.

W. M. GIFFARD, In and for that portion of the District of Kona lying between Pauoa and Manoa Valleys.

L. A. MOORE, In and for Nuuanu Valley, District of Honolulu.

WM. WEINRICH, In and for that portion of the District of Ewa lying to the West of the main government road.

JAMES GIBB, In and for that portion of the District of Ewa lying between the lands of Moanalua and Waiawa.

H. BLOOMFIELD BROWN, In and for that portion of the District of Ewa lying to the east of the main government road between the land of Waipio and the Kaukonahua Gulch.

A. A. WILSON, In and for that portion of the District of Waialua, lying between the Kaukonahua and Helemano Gulches.

GEORGE M. ROBERTSON, In and for that portion of the District of Waialua lying between the Helemano and Opaeula Gulches.

GEORGE WILSON, In and for that portion of the District of Waialua lying between the Opaeula Gulch and the Koolauloa District line.

F. MEYER, In and for that portion of the District of Waianae lying to the west of the Waianae Mountains.

MOLOKAI.

JAMES MUNRO, In and for that portion of the Island of Molokai lying to the west of Wailau Valley and the land of Mapulehu.

C. C. CONRADT, In and for that portion of the Island of Molokai including and lying to the east of Wailau Valley and the land of Mapulehu.

LANAI.

GEORGE C. MUNRO, In and for the Island of Lanai.

MAUI.

A. W. COLLINS, In and for the District of Lahaina.

DAVID T. FLEMING, In and for the District of Kaanapali.

C. E. S. BURNS, In and for the District of Wailuku.

F. F. BALDWIN, In and for the District of Hamakuapoko and the west half of the District of Hamakualoa.

W. F. POGUE, In and for the east half of the District of Hamakualoa and that portion of the District of Koolau lying to the west of Makapipi Gulch.

MARION CABRAL, In and for that portion of the District of Koolau lying to the east of Makapipi Gulch.

JOHN CHALMERS, In and for the District of Hana.

JOHN FASSOTH, In and for the District of Kipahulu.

L. VON TEMPSKY, In and for the Districts of Kula and Kaupo.

HAWAII.

G. C. WATT, In and for that portion of the north half of the District of Kohala extending from the land of Kaauhuhu to the Hamakua District line.

SAM P. WOODS, In and for that portion of North Kohala extending from the northern boundary of the land of Kawaihae I. to and including the land of Kaauhuhu.

. W. CARTER, In and for the District of South Kohala.

/. P. NAQUIN, In and for the western part of the District of Hamakua extending to the west from the boundary of the land of Paauhau to the boundary of the land of Kukaiau.

ONALD S. MACALISTER, In and for that portion of the District of Hamakua extending from and including the land of Kukaiau to the Hilo District line.

)HN M. ROSS.

. S. RICKARD, Assistant District Fire Warden, In and for that portion of the District of Hilo extending from the Hamakua District to the land of Makahanaloa.

)HN T. MOIR, In and for that portion of the District of Hilo extending from and including the land of Makahanaloa to the land of Kikala.

)HN A. SCOTT, In and for that portion of the District of Hilo extending from the Puna District line to and including the land of Kikala.

F. ECKART, In and for the District of Puna.

MES CAMPSIE, In and for that portion of the District of Kau extending from the Puna District line to and including the land of Punaluu.

EORGE GIBB, In and for that portion of the District of Kau extending from the land of Punaluu to the Kona District line.

A. McWAYNE, In and for that portion of the District of Kona extending from the Kau District line to and including the land of Kaapuna.

C. WHITE, In and for that portion of the District of Kona extending from the land of Kaapuna to and including the land of Hookena.

P. LINCOLN, In and for that portion of the District of Kona extending from the land of Hookena to and including the land of Kaawaloa.

C. WHITE, In and for that portion of the District of Kona extending from the land of Kaawaloa to and including the land of Kahaluu.

)HN A. MAGUIRE, In and for that portion of the District of Kona extending from the land of Kahaluu to the Kohala District line.

FOREST RANGERS.

Kauai.

. V. HARDY.

OSEA K. LOVELL, For the Island of Kauai.

Oahu.

AVID KAPIHE, In and for Tantalus and Makiki and Pauoa Valleys.

H. HIPPLE, In and for Palolo, Manoa, and Nuuanu Valleys.

)HN PILILAAU, In and for the Waianae District.

Maui.

MES LINDSAY, For the Island of Maui.

Hawaii.

J. W. MACKENZIE, For the Island of Hawaii.

HONORARY FOREST RANGERS.

W. H. SHIPMAN, In and for the District of Puna and Hilo, Hawaii.
BRUCE CARTWRIGHT, JR., For the enforcement of Rule IV, Division of Forestry, on Oahu.

DISTRICT FORESTERS.

Kauai.

Albert S. Wilcox, L. D. Larsen, C. H. Wilcox, Edward Broadbent, Rev. J. M. Lydgate, Walter D. McBryde, Eric A. Knudsen, B. D. Baldwin.

Oahu.

Andrew Adams, L. L. McCandless, John Herd, Paul R. Isenberg, W. W. Goodale.

Molokai.

James Munro, C. C. Conradt.

Lanai.

George C. Munro.

Maui.

A. W. Collins, F. F. Baldwin, W. F. Pogue, L. von Tempsky, Dr. J. H. Raymond, D. T. Fleming, John Fassoth.

Hawaii.

G. C. Watt, A. W. Carter, W. P. Naquin, John M. Ross, John A. Scott, George Gibb, W. R. Castle, James Campsie, John A. Maguire.

REPORT OF THE FOREST NURSERYMAN

Honolulu, Hawaii, December 31, 1918.

Superintendent of Forestry,
Honolulu, Hawaii.

Dear Sir: I respectfully submit the following report for the years 1917 and 1918:

COLLECTION AND EXCHANGE OF SEED.

We have had many applications from abroad during the past two years for seed of our exotic and indigenous plants. From Australia we received a large number of orders for algaroba seed, *Prosopis juliflora*. From other countries the demand was principally for flowering trees and shrubs. We have received in exchange seed such as different kinds of ficus, junipers, cypress, and a number of species of the pine family, etc.

TREES DISTRIBUTED FROM GOVERNMENT NURSERIES DURING 1917 AND 1918.

Oahu: 1917

Honolulu:

	Seedlings	Trans-plants	Pot Grown	Total
Sold	....	1,377	1,366	2,743
Gratis				
Arbor Day	....	....	10,490	10,490
Forest Reserves	6,000	5,000	1,495	12,495
Homesteaders	7,100	2,350	640	10,090
Military Posts	....	2,500	3,000	5,500
Parks	....	....	300	300
Schools	....	....	850	850
Street Planting	....	....	432	432
Miscellaneous	9,000	1,034	1,370	11,404
	22,100	12,261	19,943	54,304
Hawaii sub-nursery, including Arbor Day				7,568
Kauai sub-nursery, including Arbor Day				8,087
Plantation companies, etc.				283,550
				353,509

Oahu: 1918.

Honolulu:

	Seedlings	Trans-plants	Pot Grown	Total
Sold	....	830	1,795	2,625
Gratis				
Arbor Day	....	....	10,500	10,500
Homesteaders	3,000	2,803	712	6,515
Forest Reserves	7,700	2,050	286	10,036
Military Posts	....	5,390	1,604	6,994
Parks	....	....	55	55
Schools	....	250	1,266	1,516
Street and Road Planting	2,400	....	724	3,124
Miscellaneous	1,000	1,890	3,927	6,817
	14,100	13,213	20,869	48,182

Hawaii sub-nursery, including Arbor Day	6,188
Kauai sub-nursery, including Arbor Day	6,010
Plantation companies, etc.	237,522
	297,902

Total Tree Distribution, 1917 and 1918, 651,411.

Government Realizations.

1917.

Sale of Plants	$ 41.85
Rent of Office, Nursery Grounds	420.00
	$461.85

1918.

Sale of Plants	$ 45.55
Rent of Office, Nursery Grounds	420.00
Sale of aged horse	50.00
	$515.55

Preservation and Extension of Forestry and Forest Reserves.

1917.

Rent and Fees	$212.50
Sale of black sand	52.25
Sale of posts from Tantalus	2.25
Total	$267.00

1918.

Rent and Fees	$210.25
Sale of black sand	181.00
Total	$391.25

Government realizations are deposited with the Treasurer at the end of each month. Collections on account of Preservation and Extension of Forestry and Forest Reserves are deposited with the Treasurer at the end of each quarter, and go into the special fund.

PLANTATION COMPANIES AND OTHER CORPORATIONS.

The number of trees ordered by plantation companies and other corporations during 1918 was not so large as in some of the past years. The falling off, no doubt, was due to the scarcity of labor on most of the plantations.

The following is a list of trees distributed during the past two years:

	1917	1918	Total
Eucalyptus robusta	127,300	95,200	222,500
" citriodora	20,100	25,500	45,600
" globulus	1,550	42,700	44,250
" rostrata	15,000	34,000	49,000
" resinifera	3,000	10,000	13,000
" crebra	38,000	....	38,000
" rudis	....	10,000	10,000
" pilularis	5,050	....	5,050
Casuarina equisetifolia	51,000	18,200	69,200
" quadrivalvis	3,250	1,000	4,250
Grevillea robusta	10,000	....	10,000
Swietenia mahogani	1,000	....	1,000
Cryptomeria Japonica	5,000	....	5,000
Miscellaneous	3,300	922	4,222
Total	283,550	237,522	521,072

MAKIKI STATION.

The work at this station consisted principally of transplanting trees into boxes, pots and tin cans, mixing and sterilizing soil to be used for seed raising and transplanting at this station and at the Nursery on King Street.

A great deal of saw mill work is done at this station which consists of cutting up wood for seed and transplant boxes, laths for making crates for shipping plants, fence posts, etc.

HONOLULU WATERSHED.

During the year 1917, 6,054 koa, 300 kukui, and 1,484 mahogany trees were planted, and during 1918, 2,742 koa, and 686 yellow poinciana trees were planted in the Makiki Valleys on the Honolulu Watershed. Other work consisted in rooting out pests. The *Caesalpinia bonduc* is almost exterminated both in Hering and Opu Valleys.

For about three months during the summer of 1918 the men employed on the watershed were transferred to the Tantalus forest for the purpose of cutting away and pruning the trees along the road. This was done at the request of people who had occasion to use the road who complained about the very bad condition of the road through the forest. They complained that owing to the dense shade caused by the trees, the road never had a chance to dry up, consequently the soil got churned into mortar by the wagons and became so deep in parts that it was next to impossible to get over it with any kind of a vehicle. The work was certainly appreciated by the people using the road, and the good effect was plainly observed a few weeks after the work was done. Considerable work has been done on the trails running through the watershed. There are long stretches of trails that require to be kept open, not only for the convenience of those who may want to use them but as a protection during the summer months against fires.

NURSERY AND GROUNDS.

The propagation and distribution of plants has been carried on with the aid of one man with occasional help from two seed boys and the yard man during the busy season. On the grounds up to about eighteen months ago High Sheriff Jarrett provided us with two trusties to help in keeping the grounds in good condition. Owing to not having men whom he could trust to send us we have been deprived during the past eighteen months of that much needed help. After the prison help was withdrawn it became necessary to employ two extra men. The regular yardman being often required to do rough carpentry work, pipe fixing and assisting at the saw mill in Makiki, etc., left the ground during the great part of the time to be kept in order by two men.

The wooden curbing laid about twelve years ago along the walks is fast decaying, and has disappeared entirely from a number of places. New curbing ought to be laid so that the parking around the buildings and the part used by the public could be kept in a more presentable condition.

Respectfully submitted,

DAVID HAUGHS,
Forest Nurseryman.

REPORT OF THE CONSULTING BOTANIST

Honolulu, Hawaii, December 31, 1918.

The Board of Commissioners of
Agriculture and Forestry,
Honolulu, Hawaii.

Gentlemen: I beg to submit my report as Consulting Botanist for the biennial period ended December 31, 1918.

During the summer of 1917 the writer visited Southern California for the purpose of acquainting himself with the large nurseries existing in Santa Barbara. He collected seeds in the various gardens in Southern California, and purchased numerous plants from the nurseries in Santa Barbara. The plants purchased were nearly all ornamental not as yet cultivated in the Territory. Among them were quite a number of palms, and also vines of which the most noteworthy were *Bignonia Kerere,* one of the handsomest and largest flowering bignonia known to the writer, and *Vitis capensis,* a South African ornamental grape with very handsome foliage. They have been planted out on the College of Hawaii campus where they are thriving well. At about the same time quite a number of valuable plants were presented to the writer for the Territory by the Conservatories of the Golden Gate Park, San Francisco, California. Among them were several species of palms, Aroids, Pandanaceae, etc.

After his return to the islands he visited Hawaii with Commissioner Giffard and the Superintendent of the Golden Gate Park Conservatories for the purpose of collecting seeds of native plants intended for exchange purposes.

In August, 1917, the Board published Botanical Bulletin No. 4, "The Ohia Lehua Trees of Hawaii," being a revision of the Hawaiian species of the genus *Metrosideros,* with especial reference to the Hawaiian species and varieties. It is a 76 page bulletin with 31 plates, and is based on the researches by the writer on material in the Board's herbarium now in the safe keeping of the College of Hawaii. In 1917 he also published a book on "The Ornamental Trees of Hawaii." While not an official publication, it is intimately connected with the work done by the writer as Consulting Botanist.

Seeds of numerous species of plants were imported by the writer and turned over to the Board. He personally collected quantities of seed of *Acacia arabica,* a very valuable dry district

DIVISION OF ENTOMOLOGY

Report of the Entomologist

Honolulu, Hawaii, December 31, 1918.

To the Commissioners of Agriculture and
Forestry for the Territory of Hawaii.

Gentlemen: I submit herewith my report for the biennial period January 1st, 1917, to December 31st, 1918.

PROPAGATION AND DISTRIBUTION OF BENEFICIAL INSECTS.

Unsettled conditions abroad have made it inadvisable to undertake any new field work during the biennial period and on this account the work of the division has been very much restricted, being confined principally to the propagation and distribution of beneficial insects. The insects handled have been the corn leaf hopper egg parasite, the fruit fly and melon fly parasites, dung fly parasites, etc., and a tabulation of the species, the numbers propagated, and the localities to which distributed follows (see Table I). This work, which was undertaken in the beginning to facilitate and safeguard introductions, is now being applied directly to the control of the pests concerned with much practical benefit, and might be very profitably extended. The control of the corn leaf hopper on the lowlands where corn cultivation is confined to the winter months particularly demands artificial multiplication and distribution of the parasite, for there is obviously a great decimation of the parasite during the off-season, and the advantage which the hopper enjoys with respect to length of life, powers of flight and prolificness gives it a decided handicap in new plantings. The rapid increase of the hopper at this time, if allowed to go unchecked, is certain to prove disastrous to the crop, but by bringing in parasites in numbers a check is secured at once, which remains to the completion of the harvest. The same principle applies, although the conditions are not the same nor the case so obvious, with respect to the other parasites, and there is no doubt that a great deal of benefit is derived from "assisting nature" even in this small way.

INVESTIGATION PRELIMINARY TO FIELD WORK.

While enterprise has languished, the main field of work has not been entirely forgotten. New projects are being investigated, so that if it is desired to resume field operations when the time is ripe, it may be done on a firmer basis and with less delay than would be the case had the problems not been gone over in anticipation. With due regard to the full scope of the work that has already been done, it is still believed that the field has not been exhausted, and that the occasion for renewed efforts holds promise of results that will bring about an improvement in the conditions surrounding agriculture and stock-raising.

CORN LEAF HOPPER AND ITS CONTROL.

In connection with the propagation of the corn leaf hopper parasites, a study has been made of the hopper itself and statistical data collected on all the important points in its life history. The effectiveness of the parasites is proved by the high average of parasitism disclosed (close to fifty per cent).

CONTROL OF MEDITERRANEAN FRUIT FLY BY INTRODUCED PARASITES.

The collection of statistics on the parasitism of the fruit flies is being continued by the U. S. Bur. Ent. office, and the following remarks in regard to the parasitism of the Mediterranean fruit fly are quoted from their latest publication. The statistics appear in Table II:

"Thus, as seen in the table, nearly one-half of all the Mediterranean fruit-fly developing during the year were destroyed and this is entirely the result of parasitic importations. This achievement, solely due to the efforts of the Territorial Board of Agriculture and Forestry, is worthy of unusual commendation. Insufficient emphasis perhaps has been placed during recent years upon the utility of these parasites. The constant extinction of at least 45 per cent of all worms developing in fruit, apart from the destruction of this pest through other agencies already present in the islands, notable among them being the ant *Pheidole megacephala* Fabricius, without question greatly decreases the infestation of such fruits as the orange (*Citrus sinensis*) and certain varieties of mango and avocado not ordinarily susceptible to prohibitive infestation except under conditions permitting an unchecked multiplication of the fly. This point has come to light during 1917, and the statement seems justified that a 50 per cent reduction in the numbers of the fly brings little relief to its favored host fruits, but that those fruits classed as unfavored hosts show a market improvement in the degree of infestation, and some may become almost wholly free from larvae. The propagation of such fruits and the encouragement of the parasitic method of control would seem to be the most favorable method of contending with this pest in Hawaii.

"This 47 per cent reduction in the abundance of the fruit fly in Hawaii serves another purpose well worthy of mention. It is an important help contributing toward reducing the chances of its introduction to the mainland.

"The parasite *Tetrastichus giffardianus* Silvestri was more abundantly recovered from fruit collections in 1917 than in any preceding year since its liberation in the islands in 1914. It was recovered, however, only in material collected about Honolulu. Its ability to penetrate to the interior of soft fruits broken or containing holes enables it when numerous to parasitize large numbers of larvae in such fruits as the mango, the orange or common guava. The total average parasitism in larvae from all fruits during the year was materially increased through the work of *T. giffardianus* in such fruits.

"The total parasitism by all species during 1917 was 14.3 per cent. higher than in 1916. The average infestation of all fruits combined was, however, not strikingly different from that of 1916.

"As shown in the table, the parasitism by *Opius humilis* is 4.5 per cent less than in 1916, while that of *Diachasma tryoni*, *D. fullawayi* Silvestri and *Tetrastichus giffardianus* was 7.0 per cent, 5.2 per cent, and 6.6 per cent greater, respectively.'

**

CONTROL OF THE MELON FLY BY PARASITE FROM INDIA.

While data has not yet been published on the parasitism of the melon fly it is known to range from twenty to forty-five per cent on the island of Oahu, and in the Kona district of Hawaii, where circumstances are peculiarly favorable, the parasitism has proved an effective check, as shown in the following quotation from a report by the U. S. Bur. Ent. representative in Hawaii:

"A field trip to the Kona coffee district extended from April 19th to May 17th. I found conditions so interesting that the trip was extended longer than originally intended. Perhaps the most interesting situation now in evidence in the district is the control exerted over the melon fly by the newly introduced parasite *Opius fletcheri*. This parasite was liberated in the district in June, 1916. At the present time the fly is so reduced there that it is in no sense destructive. I examined carefully 400 cucumbers of various sizes, 28 young watermelons, 20 young muskmelons, 21 young pumpkins, and 2,456 ripe wild cucumbers, *Momordica sp.* I found only one egg puncture in one of the cultivated cucumbers, which was a surprising and wholly unexpected condition. None of the cucumbers had scars or deformities that are so characteristically seen in all gardens where the melon fly is present. None of the melons or the pumpkins were touched by the melon fly, nor could any injured or stung blossoms be found. The wild Momordica grows luxuriantly over large areas in Kona. Of the 2,456 fruits examined, 266 contained eggs or larvae of the melon fly. Most of these infested ones were found in an isolated spot in the center of an overgrown, abandoned cotton field. From the infested Momordicas a total of 676 melon fly larvae were secured. These were heavily parasitized by *O. fletcheri* the parasitism amounting to 96.9%. Those engaged in gardening the district are very much pleased with the new condition and report all along the line very favorably. I consider this control to be the result of two factors. One is the work of the parasite and the other is the presence of the great quantities of wild Momordicas everywhere. The Momordica fruits heavily throughout the year and is certainly a very favored host of the melon fly. The fruits are universally small, seldom being more than an inch in diameter. This permits the fly to be present constantly and in

fruits small enough to allow the parasite to reach most of the larvae. The parasitism is thus high and the flies that do reach maturity have a great abundance of a natural host constantly at hand to absorb their eggs. The cultivated gardens scattered through the district are thus attacked by a greatly reduced number of flies and these are not necessarily in a condition to deposit an excessive number of eggs for they must be continually ovipositing in the wild cucumbers in all directions, both in and about the gardens. In May, 1916, I examined 442 wild cucumbers at the same locality where the above were examined and just a few weeks prior to the liberation of the parasite. Of these, 248 were well invested. The comparison with the present condition is very interesting."

IMMIGRANT SPECIES AND THEIR MENACE.

Fortunately, no new menace to our industries has appeared during the biennial period, and with the exception of an unusually heavy infestation of bananas by mealy bugs in the summer of 1917, nothing has occurred of a nature to require more than ordinary measures of protection or control. Yet immigrant species are constantly finding their way to the islands; it is an inevitable circumstance, and we should be prepared for emergencies, such as the appearance of a really dangerous insect.

WHITE ANTS.

It is desired at this juncture to call attention to the alarming and increasing ravages of white ants. One species in particular, which has only recently gained a foothold here, is certain to become a most destructive agent to all kinds of wood and wood products as time goes on and its range becomes more extensive. They are being studied, and more detailed information concerning them will be given later.

ROUTINE WORK AND PUBLICATIONS.

A great deal of the time of the entomologist has been taken up by routine work, investigating reported cases of insect depredations, giving advice or assistance, etc. The insect collections have been maintained and added to. Some groups of insects have been studied closely, where an intimate knowledge of the insects bore on economic work in hand.

A list of the publications of the entomologist during the biennial period follows:

1. **Description of a New Species of Spalangia. Proc. Haw. Ent. Soc., v. 3, No. 4, pp. 292-294. Dung fly parasite.**
2. **Notes on Hawaiian Prosopidae. Proc. Haw. Ent. Soc., v. 3, No 5, pp. 393-399.**

3. **A New Genus of Pteroptricine Aphelininae (Hymenoptera). Proc. Haw. Ent. Soc., v. 3, No. 5, pp. 463-464. Mealy bug parasite.**
4. **The Corn Leaf Hopper. Bul. 4, Div. Ent. Haw. Bd. Agr. and For.**
5. **Natural Control of Scale Insects in Hawaii (in course of publication).**
6. **New Genera and Species of Braconidae, Mostly Malayan (in course of publication).**
7. **Control of the Melon Fly in Hawaii by a Parasite introduced from India (in course of publication).**
8. **Review of the Genus Sierola, with Description of New Species (in preparation).**
9. **Notes on White Ants in Hawaii (in preparation).**

Respectfully submitted,

DAVID T. FULLAWAY,
Entomologist.

TABLE I.

TABULATION SHOWING THE LIBERATION OF BENEFICIAL INSECTS, 1917-1918.

	Oahu	Kauai	Molokai	Maui	Hawaii	Lanai	Tot.
FRUIT FLY PARASITES.*							
Tetrastichus giffardianus	13,413	200	....	280	1,500	....	15,393
Diachasma fullawayi	1,992	....	....	228	136	....	2,356
Diachasma tryoni	8,279	3,020	....	575	1,605	62	13,541
Dirhinus giffardi	2,200	....	....	....	200	....	2,400
Opius humilis	2,242	....	....	310	110	35	2,777
Galesus silvestri	755	....	....	....	2,570	....	3,325
Total	28,881	3,020	....	1,393	6,201	97	39,792
MELON FLY PARASITE†							
Opius fletcheri	38,165	1,553	260	1,324	11,890	....	55,192
DUNG FLY PARASITES‡							
Spalangia cameroni	660	....	....	16,270	700	....	17,630
Pachycrepoideus dubius	....	....	....	2,100	....	....	2,100
Total	660	....	....	18,370	700	....	19,730
CORN LEAF HOPPER PARASITE.§							
Paranagrus osborni	234,976	28,750	15,450	145,950	35,100		460,226

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*Liberated at:

Oahu: Honolulu, Mokuleia, Waianae, Pauoa, Wahiawa, Robinson, Ewa.
Hawaii: Kohala, Kamuela, Hilo, Kapoho, Waimea, Glenwood, Mt. View.
Maui: Hana, Paia, Wailuku, Haiku.
Kauai: Lihue, Homestead.
Lanai: Keomuku.

§Liberated at:

Oahu: Honolulu, Kailua, Moiliili, Waipio, Pearl City, Kaneohe, Heeia, Aiea.
Maui: Kula, Haiku, Makawao, Paia, Wailuku.
Kauai: Lihue, Kilauea, Kapaa, Kahaheo, Kealia, Waimea.
Hawaii: Kohala, Hilo, Kapoho, Waimea, Kau, Kamuela.
Molokai: Kamelo, Pukoo.
Lanai: Keomuku.

† Liberated at:

Oahu: Honolulu, Moiliili, Niu, Mokuleia, Waianae, Pearl City, Paumalu, Aiea, Heeia, Moanalua, Robinson, Ewa, Kailua.
Hawaii: Paauhau, Hilo, Glenwood, Waimea, Kapoho, Honokaa, Kamuela.
Kauai: Hanalei, Lihue, Kealia.
Maui: Hana, Haiku.
Molokai: Kamalo.

‡Liberated at:

Oahu: Honolulu.
Maui: Paia, Haiku.
Hawaii: Kohala.

TABLE II.

TOTAL PARASITISM, BY MONTH, OF ALL LARVAE OF MEDITERRANEAN FRUIT FLY (CERATITIS CAPITATA) COLLECTED IN HAWAII DURING 1917.

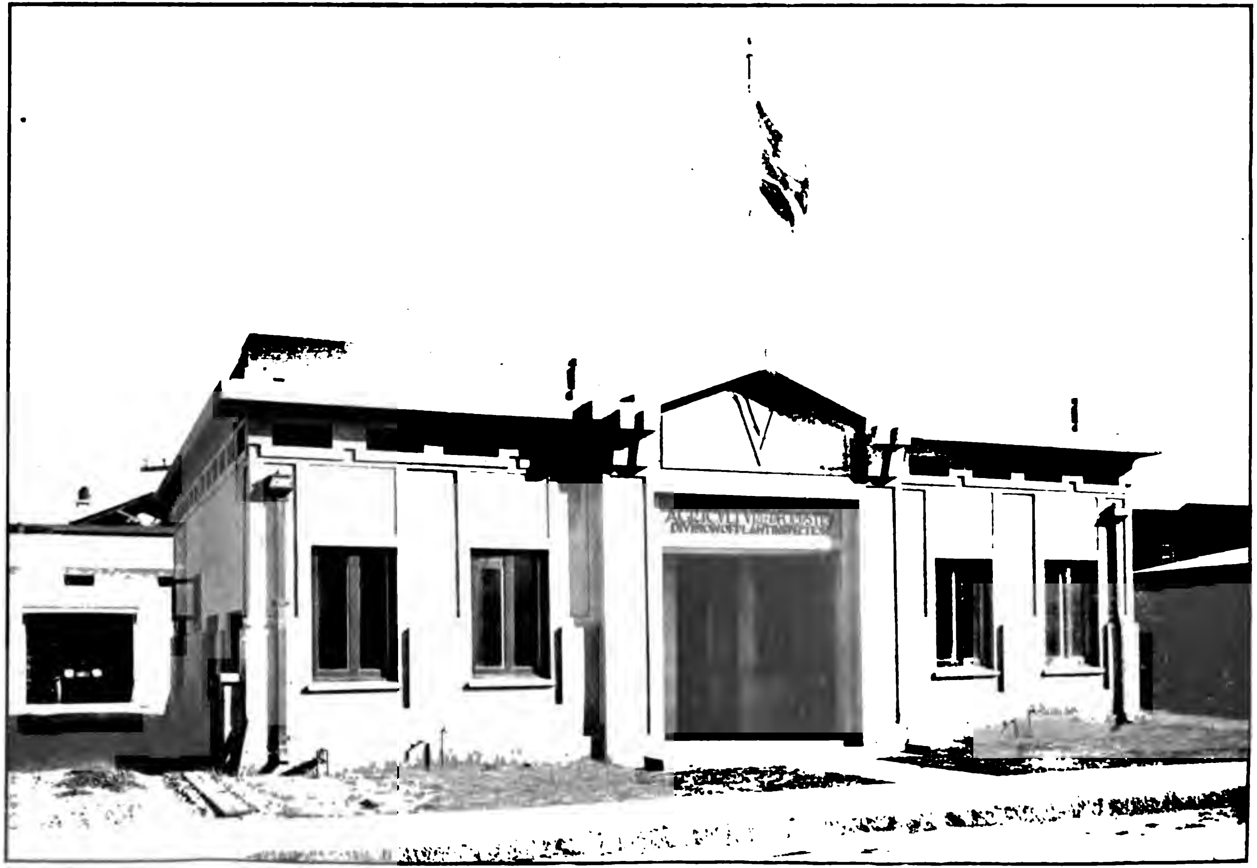
PERCENTAGE OF PARASITISM.

Month	Number of Larvae	Opius humilis	Diachasma tryoni	Diachasma fullawayi	Tetrastichus giffardianus	Total in 1917	Total in 1916
January	6,183	39.0	15.6	2.0	2.4	59.0	6.98
February	4,568	20.0	8.6	3.0	1.3	32.9	19.5
March	5,901	27.1	22.5	12.6	1.3	63.5	14.7
April	2,861	9.0	27.6	5.5	1.2	43.3	37.64
May	4,439	8.8	26.4	3.4	2.3	40.9	26.69
June	5,919	11.7	16.3	.3	7.8	36.1	27.81
July	4,125	3.9	26.6	.9	19.6	51.0	18.52
August	8,726	2.8	16.4	4.7	9.2	33.1	37.5
September	9,047	5.2	31.8	31.2	2.7	52.4	45.2
October	11,309	7.2	16.4	13.2	8.4	45.2	44.3
November	5,919	17.2	22.6	11.6	20.9	72.3	44.3
December	3,142	5.3	16.7	5.2	7.0	34.2	44.1
Average, 1917	72,139	12.7	20.3	7.3	7.2	47.5	
Average, 1916	83,304	17.2	13.3	2.1	.6		

Plate 6.

[illegible] Street, Honolulu.

Plate 6.



New Building of the Division of Plant Inspection, Kekuanaoa Street, Honolulu.

Division of Plant Inspection

Report of the Chief Plant Inspector

Honolulu, Hawaii, December 31, 1918.

Board of Commissioners of Agriculture and
Forestry, Honolulu, Hawaii.

Gentlemen: I have the honor to submit herewith the biennial report of the Division of Plant Inspection for the period from January 1, 1917, to December 31, 1918.

The work performed by the Chief Plant Inspector and his assistants during this biennial period consisted of the following:

1. The inspection of all fruits, vegetables, plants and seeds arriving in this Territory from foreign countries and the mainland in order to prevent the introduction of pests and plant diseases which do not at present exist in Hawaii and which have proven a menace to the agricultural industries of other countries.
2. The inspection of all fruit, vegetables, plants and seeds that are shipped from the port of Honolulu to ports of the other islands, the purpose of which is to prevent the spread to adjacent islands of any pest which might accidentally be introduced on Oahu through the port of Honolulu, this being the only port of entry for horticultural articles from foreign countries and consequently the most likely place where an accidental introduction of pests would make its first appearance.
3. The identification, preserving and mounting of insects taken in inspection, the acquisition of specimens of the most important economic insects occurring in foreign countries and the United States together with examples showing their life history and the nature of the damage done by them, and the building up of a reference library of economic insects and plant diseases.

In addition to the various duties pertaining to the work of inspection it has been necessary to devote much time to supervising the labor incidental to reorganizing and establishing the new Division and to moving the scattered equipment to permanent quarters.

In order to efficiently handle the constantly increasing volume of inspection work it became expedient to reorganize the Division of Entomology by making two separate divisions: the Division of Entomology and the Division of Plant Inspection, which the Legislature sanctioned at its last session, and which went into effect on July 1, 1917.

Since the activities of the Division of Plant Inspection are confined to the waterfront and immediate vicinity, upon the recommendation of the Chief Plant Inspector, the Board of Commissioners of Agriculture and Forestry agreed to move this Division to a more convenient locality. The old equipment of the Division was distributed in out of the way places on the various wharves. Examination of plants on open docks with cracks and crevices and cases of merchandise and other convenient hiding places at hand for insects that are likely to escape from such plants notwithstanding the greatest of care, is always attended with the risk of adding a new pest to our fauna.

To centralize the work and eliminate the disadvantages of the old system it was decided to erect a new building in which all the inspection work could be performed. Land was set aside on Kekuanaoa Street by the Governor and the new building was ready for occupation by the end of 1917. Since that time all work pertaining to the inspection of plants has been carried on at the new station.

Sufficient funds were not available to complete a building of the desired specifications and the Hawaiian Sugar Planters' Association generously came to our assistance with a substantial appropriation which assured the success of the undertaking.

STAFF.

During the biennial period the Division of Plant Inspection had four members at Honolulu as follows:

E. M. Ehrhorn as Chief Plant Inspector, D. B. Langford as Assistant Inspector, Edward Drew and Isaac Kahele as Inspector's assistants. On July 5, 1918, Mr. Kahele was drafted for service in the army and Mr. Minoru Mito was engaged in his place during the period of the war.

At Hilo, Brother Matthias Newell has continued as Fruit and Plant Inspector, and has been very faithful in the performance of his duties. On January 1, 1917, Mr. Will J. Cooper was appointed Fruit Inspector at Kahului, Maui. This was found necessary on account of the congestion at the Port of Honolulu owing to war conditions. Since taking up the work Mr. Cooper has found several shipments of turnips infested with the raddish maggot and had them destroyed.

Mr. E. E. Madden, Mahukona, Hawaii; Mr. Geo. B. Leavitt, Eleele, Kauai; and Mr. G. C. Munro, Keomoku, Lanai, are acting as Honorary Inspectors for these places and as all produce for the smaller ports is held and examined at the port of Honolulu these gentlemen act only as a safeguard for possible infractions of our rules and regulations.

BUILDINGS AND EQUIPMENT.

The new buildings of the Division of Plant Inspection consist of an administration building and fumigating units. The administration building is of reinforced concrete and is provided with a general office, Chief Plant Inspector's office, library, laboratory, plant room and quarantine room with attached incinerator.

The laboratory is equipped with the most improved scientific instruments and apparatus necessary for the performance of work incidental to inspection; mounting, preserving and identifying insects collected in inspection, preserving and mounting specimens for record and exhibition and for sterilizing infected materials. There is a growing reference library pertaining principally to economic entomology and plant diseases which is indispensable for the purpose of keeping apace with the discoveries and problems met with by entomologists in other parts of the world and which enables us to be on guard for new pests that appear in countries with which we are in communication by steamer.

The plant room is designed for the safe and efficient examination of all plant shipments and the danger of escape of insects is reduced to a minimum. Provision is made for making the room air-tight in order that it may be used for fumigation in case of emergency. Adjacent to the plant room is an incinerator in which infested or diseased plants, fruit, packing or other dangerous material is burned. The incinerator is heated with a rotary crude oil burner to a temperature of 2000° Fahr.

The quarantine room is constructed with a low ceiling to facilitate the capture of any insect which may escape during examination. Plant shipments that show indications of dangerous insects are first opened in this room; however, shipments showing infestation of dangerous pests are immediately destroyed by burning.

The two fumigating units are in a separate building also of reinforced concrete with a capacity of 2,500 cubic feet and 3,800 cubic feet, respectively. The doors are specially designed to prevent the leakage of gas.

VESSELS TOUCHING AT HONOLULU.

Every vessel touching at Honolulu from foreign and mainland ports is met and boarded as soon as it reaches the wharf. Foreign ships are likely to have on board fruit or vegetables for consumption on the voyage or growing plants in transit or for purposes of decoration. These are frequently infested with insects which are always a source of danger from their hatching on board and getting ashore where abundant vegetation for their reception is to be found adjacent to the waterfront. A thorough search is made of these vessels, and if in our judgment any part of their cargo is liable to harbor insects, immediate steps are taken for our protection. Copies of the laws and regulations of the Board of Agriculture and Forestry as well as those of the Federal Horticultural Board are supplied to the proper authorities on all vessels in order that they may be fully acquainted with the requirements of the Territory in these matters and take the necessary precautions as well as to avoid inconvenience and delay to themselves.

INSPECTION OF PLANTS.

Immediately on arrival, all consignments of plants are taken to the Plant Inspection building and subjected to a rigid examination, the soil removed from the roots and when necessary replaced with moss or sterilized soil. When evidence is found of infestation by insects or disease they are at once treated before delivery or burned as the case warrants.

POST OFFICE INSPECTION.

Visits to the Post Office are made daily or more frequently if necessary and each parcel of seeds, fruits or plants is examined and proper treatment accorded those found infested. Here again we are very fortunate in having the hearty cooperation of the Postmaster and his assistants. A special locker is set aside for all packages containing plants, seeds and other vegetable matter and these are deposited therein, and are held until passed by the Plant Inspector.

PLANT AND FRUIT INSPECTION.

During the biennial period 1,433 vessels arriving at the ports of Honolulu, Hilo and Kahului were inspected. Of this number 614 vessels carried vegetable matter consisting of 24,843 lots and 566,268 packages. Of this amount 577,261 packages were fruit and vegetables mostly from the mainland of the United States and imported for consumption, 4,296 packages were seeds of trees, flowers, vegetables and cereals and 4,691 packages were plants.

From these shipments 1,314 packages were destroyed by burning, 4,729 packages were fumigated before delivery and 964 packages were returned to the shipper on account of being infested with insect pests or fungus diseases or being contraband under the rulings of the Federal Horticultural Board of Washington, D.C., of which the writer, Mr. D. B. Langford and Mr. Edward Drew are Collaborators.

Plate 7.

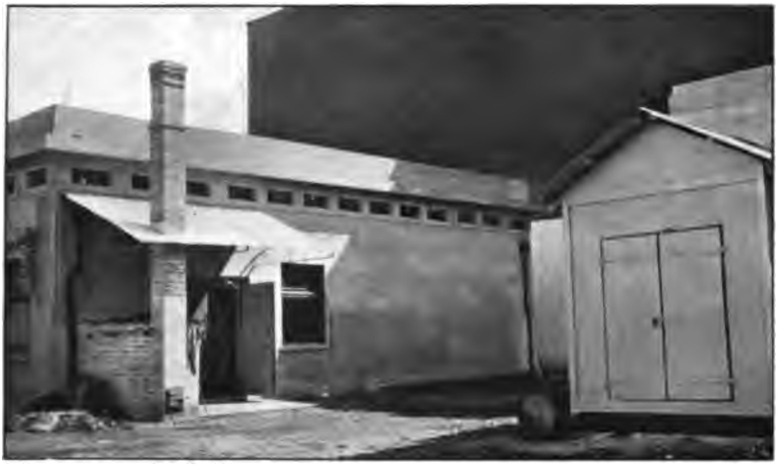


Fig. 1. Rear of New Plant Inspection Building, Honolulu, Showing Incinerator.

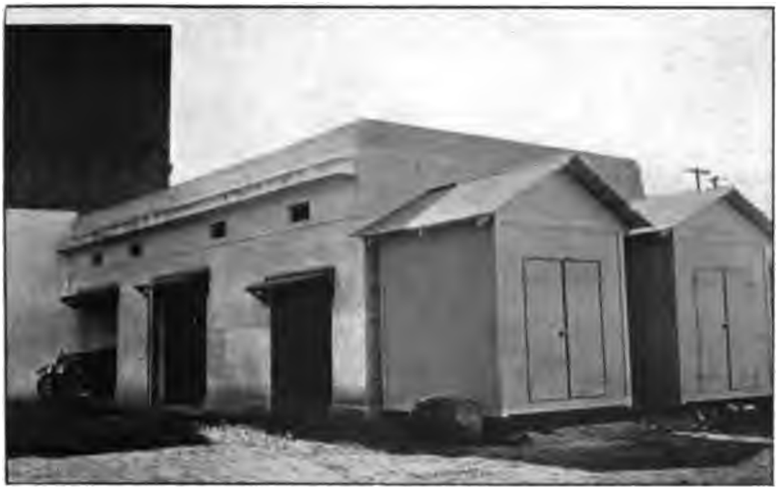


Fig. 2. New Fumigating Units.

The tables in the appendix give a summary of the inspection work performed at Honolulu, Hilo and Kahului, as well as the Inter-Island Inspection (see Appendix, Nos. 1 to 12).

RICE AND BEAN SHIPMENTS.

Rice and beans being the staple food of our large Oriental population, it follows that imports of these commodities are very extensive and their inspection is of considerable importance. The imports of rice and beans for the years 1917-1918 amounted to 771,746 bags of rice and 61,435 bags of beans. With the exception of a few small shipments which were thoroughly fumigated before delivery was allowed, rice and beans were of good quality and free from insect pests.

In past years considerable difficulty has been experienced especially with rice and beans of the old crop being infested with the various moths and beetles that affect stored cereals. With our limited facilities for the fumigation of large quantities of these products, their disposal constituted a difficult problem. The amended Rule III of the Board of Agriculture and Forestry as amended June 8, 1918, so as to require the fumigation of all rice at the port of debarkation has materially improved the situation.

AUSTRALIAN WHEAT.

Several large consignments of wheat from Australia were slightly infested with the Lesser Grain Borer, *Rhizopertha dominica*. Fortunately we were able to fumigate it at once and prevent the introduction of this pest to the warehouses of Honolulu.

INSPECTION OF IMMIGRANTS' BAGGAGE.

One of the very important duties of this Division is the examination of the baggage of immigrants. These people, principally Orientals, almost invariably have in their possession packages of sugar cane, fruit, vegetables and frequently plants brought for food or as presents to friends in Honolulu. Singing crickets in cages, leeches, snails and various other creatures are met with from time to time. Such belongings are decidedly more dangerous than those we would ordinarily expect to find in regular commercial consignments for the reason that they usually come from the small plots of Oriental homes where there is seldom the knowledge or facility for the control of noxious insects.

Through the courtesy of the U. S. Customs and Immigration inspectors we are able to examine thoroughly every piece of baggage belonging to immigrants and burn all suspicious packages.

During the past biennial period approximately 108,416 pieces of such baggage were examined from which 676 lots of fruit, vegetables, etc., were taken and destroyed.

INTER-ISLAND INSPECTION.

The usual inspection of horticultural products consigned to other island ports has been continued. With the improved facilities for inspection it is now possible to control the shipments of soil on the roots of plants and thereby minimize the danger of the spread of insects and diseases not yet established on the other islands. The Hawaiian Sugar Planters' Experiment Station has been authorized to attend to the inspection of sugar cane for planting on the various plantations of the islands and no sugar cane is received for shipment unless examined and certified by them. All sugar cane which is found in the possession of the traveling public is confiscated and destroyed. In this way we hope to prevent the spread of cane diseases from the Island of Oahu to any of the other islands.

During the biennial period 1,396 steamers plying between Honolulu and ports of the other islands were attended to and 24,114 packages of plants, fruits and vegetables were inspected. Of this number 330 packages were rejected either on account of infestation or having undesirable soil attached to the roots of plants.

FUMIGATION.

Since moving to the new building on Kekuanaoa Street, in addition to fumigating shipments of rice and other cereals from foreign ports, we have been able to fumigate a large amount of grain and other stored food products which have become infested while in storage in Honolulu. The cost of the chemicals used for such fumigation was paid by the owner and not by this Division. As local merchants realize more and more the importance of keeping such commodities free from insect infestation the demand for this work is rapidly increasing. The Quartermaster Department of the U. S. Army frequently calls upon us to handle quantities of flour and rice that taxes us to the limit of our ability. In case of an outbreak of some contagious disease when bedding and personal effects would require fumigation this is the only Territorial institution available for work of this nature.

It has always been the policy of this Division to cooperate in every way with federal, territorial and other institutions when the results are for the good of the Territory at large. Constant vigilance is necessary to guard this Territory from invasion of injurious insects and plant diseases, and if we are to continue this policy it is of the utmost importance that more units be added to the fumigating plant as soon as possible.

PESTS INTERCEPTED IN INSPECTION.

In addition to our improved facilities for carrying on the work of inspection two factors have contributed to lessen the danger of introducing destructive pests: the war, which reduced shipping accommodations, and the rigid restrictions imposed upon horticultural importations by the Federal Horticultural Board. Notwithstanding these factors we have intercepted and destroyed numerous insects and diseases some of which were they to secure a foothold in the Territory would seriously interfere with our agricultural industries.

The principal media for the carrying of insects and plant diseases are plants and soil and the moss or other material in which they are packed, grain and other stored food products, and fruit and vegetables which arrive by freight, mail and baggage. Naturally the great bulk of imports come by freight but the articles found in the mail and baggage are the most prolific carriers of unwelcome visitors and require the greatest care in their detection. Commercial shipments almost invariably are thoroughly inspected at the place of origin, and infested products are rarely presented for shipment, while mail and baggage, more particularly the former, come from every part of the globe, and the possibilities of infestation are legion. Following are interceptions which deserve particular mention:

Pineapple Mite, *Stigmaeus floridanus.*

This pest was discovered in a consignment of pineapple suckers in the mail from Florida. In addition to the damage caused by the feeding of the insect, it is said to be the means of carrying dangerous plant diseases which gain access to the tissues of the leaf through its punctures.

Argentine Ant, *Iridomyrmex humilis.*

Specimens of this dreaded pest were discovered in the soil on the roots of a consignment of plants from California.

Curculionid Beetle.

In the Orient the grubs of a beetle of this family subsist on the roots of *Thuya orientalis* and *Azalea*, and being under ground control measures are difficult. Many larvae of this beetle were taken from the roots of potted plants from Japan.

White Fly, *Aleyrodes citri.*

This insect causes immense damage to citrus crops in countries where it has become established, and growers are annually put to great expense and labor to keep the pest in check. The white fly was found on citrus plants from Japan.

White Ants, *Termites.*

The white ant is at present well known in Honolulu especially to owners of wooden buildings. Fortunately the most destructive species which attack living plants in the Philippines, East Indies and Polynesia have not gained a foothold in Hawaii. Only recently we burned a large colony discovered in a consignment of yams and banana shoots from Manila.

On plants, in soil and other materials we have record of taking in course of inspection 10 species of scale insects, *Coccidae;* 9 species of beetles, *Coleoptera;* 4 species of moths and butterflies or their larvae; *Lepidoptera*; 18 species of ants, *Hymenoptera,* 12 species of roaches and grasshoppers, *Orthoptera,* 16 species of miscellaneous other insects and 6 species of fungus diseases; on fruit and vegetables we have found 9 species of scale insects, 3 species of moths and 6 species of various other insects; on grain and other stored food products, 7 species of beetles and 4 species of moths, making a total of 104 species. In addition to the insects noted, centipedes, scorpions, pill bugs, slugs and snails, and on one occasion, leeches have been taken from different shipments arriving in the Territory.

RULES AND REGULATIONS.

During the past biennial period the following changes have been made in the rules and regulations of the Board of Agriculture and Forestry which pertain to this Division:

Rule I.—Rule I, which deals with general inspection, was amended June 8, 1918, to broaden the power of this Division and to comply with the rules and regulations of the Federal Horticultural Board, and includes shipments of plants, fruit, seeds, etc., from the mainland as well as from foreign countries (see Appendix No. 13).

Rule III.—Rule III was amended June 8, 1918, to require all rice shipments from Japan to be fumigated at the port of debarkation before they are accepted for shipment (see Appendix No. 14).

Rule XIX—It has recently been discovered that a beetle, *Metamasius ritchei,* Marshall, is doing serious damage to pineapples in Jamaica. In order to give ample protection to the pineapple industry from the ravages of this insect, Rule XIX was approved by the Governor June 8, 1918. This prohibits the importation of pineapple plants or suckers from the West Indies and Central America including the Canal Zone (see Appendix No. 15).

While under Rule I we are given perfect control over the introduction of plant shipments we believe that when a serious pest is known to occur in a certain locality menacing an industry, specific rules regulating the importation of the article in question will preclude the possibility of introducing its pests.

Plate 8.

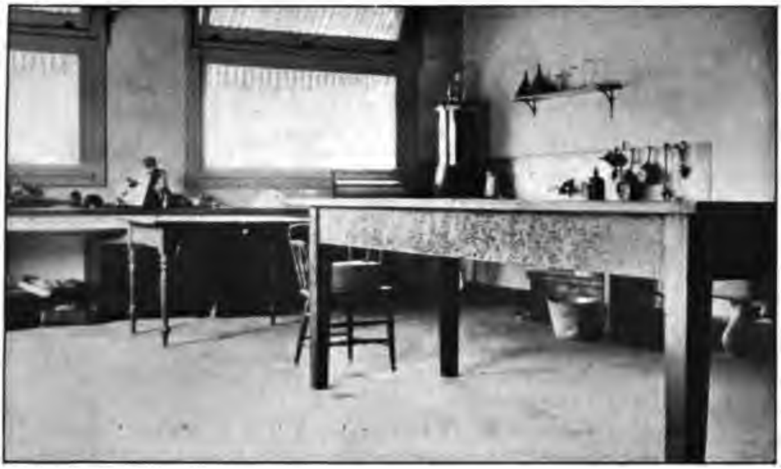


Fig. 1. Plant Room Laboratory in New Plant Inspection Building.

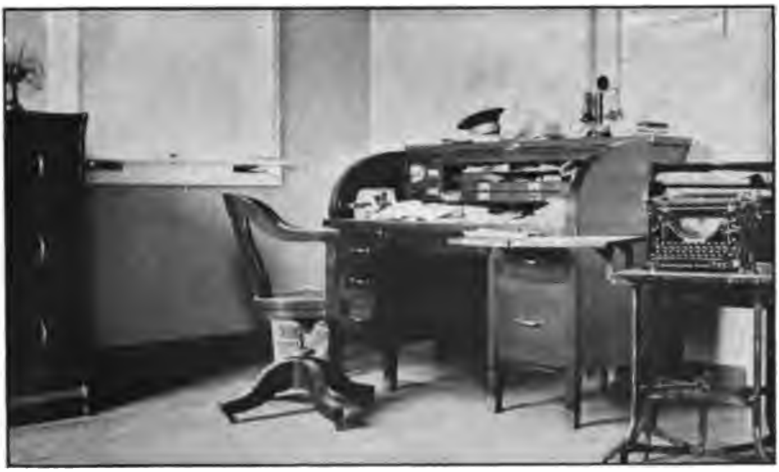


Fig. 2. Chief Plant Inspector's Office, Honolulu.

Copies of the rules of this Division have been sent to all nurserymen and seed stores who have shipped seeds or plants into the Territory during the past two years.

FEDERAL HORTICULTURAL BOARD.

The Federal Horticultural Board, of which members of this Division are Collaborators, continues invaluable in its assistance in cooperation with our department. The fact that the importation of plants, seeds and other plant products are under federal control is an incentive to importers to exercise extreme care in the quality of their selections of nurserystock. The regulations of this Board have caused all progressive foreign countries to institute an efficient system of inspection of nursery stock under government supervision. This immediately produces a marked improvement in the quality of their horticultural exports and naturally gives greater security from the danger of a foreign insect pest or disease gaining admission to this Territory.

We have been in correspondence with the Federal Horticultural Board and the post office department and have succeeded in securing permission to destroy parcels of prohibited plants, seeds, etc., arriving by mail and which are found to be infected with dangerous insects or diseases. Heretofore we were allowed to fumigate such parcels, but it was required by law to return them to the country of origin. Ordinarily fumigation is sufficient to destroy insect life, but there is always the possibility that some pest will escape in the post office, make its way to the open and become established. When such articles are burned at once no escape is possible.

The following Notices of Quarantine and other restrictive orders have been issued by the Federal Horticultural Board since January 1, 1917:

Notice of Quarantine No. 26, effective June 1, 1917:

Prohibits the interstate movement of five-leaved pines, currant and gooseberry plants from all states east of and including the States of Minnesota, Iowa, Missouri, Arkansas, and Louisiana to all points outside this area; prohibits further the interstate movement of five-leafed pines and black currant plants to points outside the area comprising the States of Maine, Vermont, Massachusetts, New Hampshire, Rhode Island, Connecticut and New York on account of the white-pine blister rust.

Notice of Quarantine No. 27; Superseded or Revoked.

Notice of Quarantine No. 28, effective Aug. 1, 1917:

Prohibits the importation from eastern and south-eastern Asia (including India, Siam, Indo-China and China), the Malayan Archipelago, the Philippine Islands, Oceanica (except Australia, Tasmania and New Zealand), Japan (including Formosa and other islands adjacent to Japan), and the Union of South Africa, of all species and varieties of

Citrus fruits, on account of citrus canker, except that oranges of the mandarin class (including satsuma and tangerine varieties) may be imported on compliance with the conditions prescribed in the regulations of the Secretary of Agriculture.

Notice of Quarantine No. 29; effective Jan. 1, 1918.

Prohibits the importation for any purpose of any variety of sweet potatoes or yams (*Ipomea batatas* and *Discorea spp.*) from all foreign countries and localities, on account of the sweet potato weevil, *Cylas spp.* and the sweet potato scarabee, *Euscepes batatae.*

This notice of quarantine does not apply to Hawaii and Porto Rico.

Notice of Quarantine No. 30; effective Jan. 1, 1918.

Prohibits the movement from the Territories of Hawaii and Porto Rico into or through any other Territory, State or District of the United States of all varieties of sweet potatoes and yams (*Ipomea batatas* and *Discorea spp.*) regardless of the use for which same are intended, on account of the sweet potato weevil (*Cylas formicarius*) and the sweet potato scarabee, *Euscepes batatae.*

Notice of Quarantine No. 31; effective April 1, 1918.

Prohibits the importation for any purpose of any species or variety of banana plants, *Musa spp.* from all foreign countries and localities, on account of the banana root borer, *Cosmopolites sordidus.*

[redacted].

Notice of Quarantine No. 32; effective April 1, 1918.

Prohibits the movement from the Territories of Hawaii and Porto Rico into or through any other Territory, State or District of the United States of any species or variety of banana plants regardless of the use for which they are intended, on account of two injurious weevils, *Rhabdocnemis obscurus* and *Metamisius hemipterus.*

Notice of Quarantine No. 33, effective July 1, 1918.

Regulates the movements interstate to any point outside the quarantine towns and territory, or from points in the generally infested area to points in the lightly infested area, of stone or quarry products and of the plants and plant products listed therein. The quarantine covers portions of the New England States.

Notice of Quarantine No. 34, effective Oct. 1, 1918.

Prohibits the importation for any purpose of any variety of bamboo seed, plants or cuttings thereof capable of propagation, including all genera and species of the tribe *Bambusae*, from all foreign countries and localities, on account of dangerous plant diseases, including the bamboo smut, *Ustilago shiraian.* This quarantine does not apply to bamboo timber consisting of the mature dried culms or canes which are imported for fishing rods, furniture-making, or other purposes, or to any kind of article manufactured from bamboo, or to bamboo shoots cooked or otherwise preserved.

Notice of Quarantine No. 35, effective June 1, 1919.

Regulates the movement interstate to any point outside the townships of Delran, Chester, and Cinnaminson, Burlington County, New Jersey, of green corn, commonly called sweet or sugar corn, on account of the Japanese Beetle, *Popilia japonica.*

Notice of Quarantine No. 36, effective Oct. 1, 1918.

Prohibits the movement interstate to any point outside of the quarantined area of corn fodder, roasting ears, corn on the cob and corn cobs on account of the European corn borer, *Pyrausta nubilalis.*

Citrus fruits, on account of citrus canker, except that oranges of the mandarin class (including [redacted] varieties) may be imported [redacted] in the regula-

Other Restrictive Orders.

The order of March 1, 1917 (Amendment No. 1 with Regulations to Notice of Quarantine No. 24), prohibits the importation of Indian corn or maize in the raw or unmanufactured state from the countries and localities listed in Notice of Quarantine No. 24, except under permit and in accordance with the other provisions of the regulations issued under said order, on account of injurious diseases of Indian corn.

The order of June 23, 1917, prohibits the importation of cottonseed cake, meal, and other cotton seed products, except oil, from all foreign countries, and a second order of June 23, 1917, prohibits the importation of cotton seed oil from Mexico except under permit and in accordance with the other provisions of the regulations issued under said orders, on account of injurious insects including the pink bollworm.

The order of June 27, 1917 (Notice of Quarantine No. 28 with Regulations), prohibits the importation from the countries and localities listed therein of all species and varieties of Citrus fruits, excepting only oranges of the mandarin class (including satsuma and tangerine varieties), on account of the citrus-canker disease. Oranges of the mandarin class (including satsuma and tangerine varieties) may be imported under permit and in accordance with the other provisions of the regulations issued under said order.

Respectfully submitted,

EDW. M. EHRHORN,
Chief Plant Inspector.

APPENDIX NO. 2.
HILO INSPECTION
1917

Month.	Vessels Inspected	Vessels Carrying Veg. Matters	PASSED		Fumigated	Burned	TOTAL INSPECTED		Seeds	Plants	Cabbages	Celery	Lemons	Onions	Oranges	Potatoes	Rice	Beans
			Lots	Parcels			Lots	Parcels										
Jan.	7	4	193	3,293	....	....	193	3,293	10	9	....	14	37	240	818	916	....	....
Feb.	7	5	228	2,202	....	....	228	2,202	4	6	....	9	7	346	453	761	1,550	296
Mar.	7	4	207	3,522	....	....	207	3,522	8	15	....	4	40	132	912	1,406	....	....
Apr.	6	4	120	1,391	....	....	120	1,391	4	6	....	....	25	99	500	460	1,190	239
May	7	4	126	2,196	....	....	126	2,196	9	13	....	4	37	37	227	905	....	....
June	9	5	210	2,013	....	....	210	2,018	1	3	1	....	45	25	819	318	4,852	268
July	8	4	214	2,167	....	....	214	2,167	....	....	1	12	31	242	549	384	....	....
Aug.	7	2	163	2,063	....	....	168	2,068	12	4	1	5	29	367	347	592	3,474	237
Sept.	5	3	167	2,441	1	....	168	2,442	....	8	....	8	45	358	398	843	....	....
Oct.	9	4	167	3,286	....	....	167	3,286	4	....	....	9	41	688	111	1,323	3,785	309
Nov.	9	2	160	3,039	....	1	161	3,040	....	1	....	9	28	348	518	802	....	....
Dec.	7	3	143	3,762	....	....	148	3,762	1	....	1	6	33	387	1,068	825	2,500	285
Total	88	44	2,098	31,375	1	1	2,096	31,877	53	60	4	70	398	3,259	6,715	9,585	17,301	1,684

HILO INSPECTION
1918

Month.	Vessels Inspected	Vessels Carrying Veg. Matters	PASSED		Fumigated	Burned	Seeds	Plants	TOTAL INSPECTED		Apples	Cabbages	Celery	Lemons	Onions	Oranges	Potatoes	Rice	Beans
			Lots	Parcels					Lots	Parcels									
Jan.	2	2	116	2,554	....	....	....	1	116	2,554	429	....	3	16	307	558	1,155	....	....
Feb.	4	2	88	1,628	....	....	....	....	88	1,628	276	....	6	7	169	281	832	4,304	149
Mar.	5	1	72	1,416	....	....	....	4	72	1,416	106	....	8	5	148	284	817	....	....
Apr.	6	3	118	2,090	....	....	....	....	118	2,090	385	....	4	16	319	270	972	900	569
May	5	2	82	1,896	....	....	13	2	82	1,896	379	....	....	9	361	189	885	....	....
June	4	1	107	2,470	....	....	5	1	107	2,470	21	....	1	28	380	287	1,502	....	....
July	4	1	110	2,316	....	....	....	....	110	2,316	38	....	4	19	527	305	1,228	....	....
Aug.	7	3	142	2,344	....	....	....	....	142	2,344	640	....	9	24	443	238	723	2,281	596
Sept.	6	2	121	1,795	....	....	....	....	121	1,795	415	....	4	25	608	90	381	....	....
Oct.	5	3	152	2,412	1	2	2	3	153	2,415	1,142	2	28	6	251	43	630	2,980	579
Nov.	5	2	97	2,861	....	....	....	....	97	2,861	984	....	....	6	311	24	1,305	....	....
Dec.	4	3	152	3,762	....	....	....	....	152	3,762	1,158	....	6	33	387	1,063	825	2,500	259

Month.	Vessels Inspected	Vessels Carrying Vegetable Matters	Lots	Parcels	Burned	Plants	Lots	Parcels	Celery	Lemons	Onions	Oranges	Potatoes
Jan.	14	2	76	581	....	....	76	581	13	3	115	127	135
Feb.	16	2	78	511	....	2	78	511	1	7	45	129	141
Mar.	11	2	49	305	....	....	49	305	1	15	8	114	13
Apr.	13	2	61	373	....	....	61	373	5	7	27	117	75
May	12	3	53	421	....	....	53	421	4	7	4	251	45
June	24	3	80	625	4	2	82	629	9	15	....	357	69
July	16	2	52	489	4	....	53	493	6	10	20	212	24
Aug.	11	3	48	319	2	....	49	321	6	2	20	97	32
Sept.	13	3	90	779	3	5	91	782	11	9	77	98	259
Oct.	11	3	79	709	1	....	80	710	13	10	47	130	175
Nov.	13	2	75	699	....	2	75	699	8	10	93	107	110
Dec.	3	1	74	762	....	....	74	762	....	12	63	150	198
Total	157	28	815	6,573	14	11	821	6,587	77	107	519	1,889	1,276

KAHULUI INSPECTION
1918

Month.	Vessels Inspected	Vessels Carrying Vegetable Matters	PASSED		Plants	TOTAL INSPECTED		Apples	Celery	Lemons	Onions	Oranges	Potatoes
			Lots	Parcels		Lots	Parcels						
Jan.	7	3	64	1,007	....	64	1,007	301	2	6	169	185	327
Feb.	6	2	38	451	4	38	451	147	1	4	93	107	89
Mar.	5	2	44	314	....	44	314	90	1	2	53	89	69
Apr.	3	2	17	185	1	17	185	60	1	2	14	52	52
May	5	3	50	673	1	50	673	145	....	8	85	182	261
June	2	2	52	707	....	52	707	....	....	5	84	101	476
July	5	2	50	344	....	50	344	5	....	8	89	41	126
Aug.	6	3	28	144	....	28	144	50	....	5	8	68	8
Sept.	5	1	4	58	....	4	58	55	....	1	....	....	....
Oct.	3	1	29	295	....	29	295	135	....	4	95	11	32
Nov.	4	1	9	520	....	9	520	195	....	10	153	5	130
Dec.	7	1	5	319	....	5	319	143	....	5	33	33	95
Total	51	23	390	5,017	6	390	5,017	1,126	5	60	876	824	1,665

APPENDIX NO. 6.
FRUITS AND VEGETABLES RECEIVED IN HONOLULU DURING 1917
(FOREIGN)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Apples	23	6	17	8	22	7	2	5	2	5	6	7	110
Asparagus	5	3	2	5	13	2	2	......	......	......	2	4	38
Beans	53	......	600	......	......	40	......	42	275	30	24	110	1,174
Bamboo Shoots	......	......	......	1	11	1	......	......	......	......	2	......	15
Caladiums	89	......	8	......	......	......	......	......	......	......	1	......	98
Chestnuts Gr.	40	15	10	8	6	......	10	......	......	......	365	1	455
Chestnuts, Water	87	22	30	34	41	7	12	21	29	7	40	40	370
Cocoanuts	......	......	......	......	6	......	......	150	......	25	......	218	399
Fruit	1	12	1	5	2	......	2	1	4	1	8	2	39
Garlic	21	4	8	23	107	18	4	9	10	3	15	6	228
Grape Fruit	4	......	2	8	12	5	......	3	1	1	1	......	37
Gingers	29	17	11	15	37	1	10	16	3	5	15	17	176
Horse Radish	5	3	2	3	9	2	1	1	1	3	3	3	36
Lemons	5	......	2	......	......	......	......	......	......	......	......	......	7
Yams	71	30	14	19	49	13	20	20	37	5	58	87	378
Nuts	5	......	......	......	......	......	......	......	......	1	1	......	7
Onions	2	703	1,693	4,516	359	1	403	23	2	......	9	3	7,714
Oranges	27	14	23	11	27	9	10	11	5	3	13	12	165
Olives	1	......	......	......	......	2	......	......	2	......	......	......	5
Pomelos	5	......	7	1	2	1	......	......	......	......	......	2	18
Pomegranates	......	1	......	......	......	......	1	......	......	......	......	......	2
Peanuts	282	34	50	......	275	26	4	100	548	......	......	......	1,319
Plants	9	4	797	40	86	214	4	187	15	......	16	21	1,393
Sand-pears	10	4	6	2	5	......	4	......	2	......	4	2	39
Quinces	......	......	143	......	......	......	......	......	......	......	......	......	143
Seeds	47	92	......	71	112	16	68	60	65	112	168	104	915
Corn	......	......	......	......	5	......	......	......	......	......	......	......	5
Potatoes	37	3	20	12	1,492	......	1	31	1	......	1	1	1,599
Wheat	......	......	......	......	......	1,500	......	......	......	......	......	......	1,500
Sweet Potatoes	19	4	1	8	17	6	1	3	......	3	7	3	72
Tangerines	20	1	18	16	9	......	1	......	......	......	7	11	83
White Nuts	6	5	......	......	3	......	......	......	9	......	12	1	36
Taro	2	1	......	2	......	......	1	......	......	1	5	......	14
Trees	......	......	......	1	......	......	......	......	......	......	......	1	2
Vegetables	1	1	9	......	......	1	1	1	12	2	15	10	53
Bulbs	58	2	......	......	......	1	2	2	1	......	17	9	96
Pears	......	......	......	......	......	......	......	......	......	......	......	1	1
Total	964	981	3,469	4,809	2,709	562	691	1,024	207	815	626	1,868	18,725

APPENDIX NO. 7.
FRUITS AND VEGETABLES RECEIVED IN HONOLULU DURING 1918
(FOREIGN)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Apples	4	7	5	1	5	3	......	......	7	1	1	5	39
Asparagus	6	5	......	1	4	2	2	......	......	......	......	......	20
Bamboo Shoots	......	......	......	1	2	......	......	......	......	......	......	......	3
Beans	......	248	10	115	101	100	40	30	101	294	68	......	1,107
Chestnuts, Water	47	28	9	65	10	15	12	4	......	21	36	51	298
Caladiums	......	42	......	......	......	......	......	......	......	......	......	......	42
Carrots	......	......	......	......	......	......	32	26	......	......	......	......	58
Chestnuts, Gr.	......	......	......	......	......	......	......	......	51	......	......	......	51
Cocoanuts	......	......	......	......	......	4	......	8	......	......	......	......	12
Corn	......	......	1	......	......	......	2	......	......	......	......	......	3
Fruit	2	3	1	......	......	2	......	......	5	......	1	......	14
Garlic	9	2	4	8	4	7	21	17	7	3	1	11	94
Grape Fruit	......	1	1	1	4	3	5	3	2	......	......	......	20
Horse Radish	6	4	1	2	2	1	1	......	2	......	1	......	20
Lemons	......	1	......	1	......	1	......	......	......	......	1	2	6
Limes	......	......	......	......	......	1	......	......	......	......	......	......	1
Gingers	34	2	11	21	4	7	20	20	58	3	9	23	212
Nuts	4	1	6	......	2	2	5	......	1	5	......	4	30
Onions	2	4	137	2	10	1	4	4	2	5	......	......	171
Oranges	10	10	9	3	3	7	4	5	4	......	8	4	67
Peas	......	......	......	3	......	......	......	......	......	......	496	366	865
Parsnips	......	......	......	......	......	......	1	......	......	......	......	......	1
Wheat	......	......	......	......	411	......	......	......	700	302	......	......	1,413
Peanuts	114	50	136	20	......	175	103	146	166	30	......	......	940
Pears	......	......	......	......	......	......	......	......	......	......	......	1	1
Persimmons	......	......	......	......	......	......	......	......	......	......	2	......	2
Plants	15	4	47	54	28	4	99	......	201	1	880	68	1,396
White Nuts	8	7	......	......	......	......	......	......	......	1	4	......	20
Pomelo	......	1	......	......	......	......	......	......	......	......	4	2	7
Seeds	100	119	110	51	29	49	140	57	142	35	154	20	1,006
Sand Pears	2	5	1	1	3	2	4	5	3	1	......	......	27
Potatoes	1	40	......	2	1	......	......	3	1	......	......	......	48
Sweet Potatoes	5	6	6	8	......	1	9	2	4	......	4	......	45
Tangerines	12	7	11	2	......	......	......	......	......	......	4	4	40
Taro	1	......	1	......	......	......	......	......	......	......	2	......	4
Yams	59	18	4	42	15	......	29	25	37	3	26	34	292
Vegetables	2	6	......	1	8	......	......	1	......	3	......	......	21
Trees	......	......	......	......	......	13	......	......	......	......	......	......	13
Bulbs	8	2	......	1	1	......	......	......	......	......	11	7	30
Total	451	623	511	406	647	400	533	356	1,489	718	1,708	602	8,439

APPENDIX NO. 8.
FRUITS AND VEGETABLES RECEIVED IN HILO DURING 1917.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Apples	873	875	765	161	776	42	291	392	472	808	1,029	1,158	7,182
Apricots	......	......	......	......	......	181	46	......	......	......	......	......	227
Artichokes	......	1	1	5	......	1	......	......	1	2	2	1	13
Beans	62	47	24	19	......	......	......	25	......	20	18	10	225
Cabbage	......	......	......	......	......	1	1	1	1	......	......	1	5
Asparagus	......	......	......	......	......	......	1	......	......	......	......	1	2
Cauliflower	27	21	23	18	24	26	25	8	9	7	15	4	207
Celery	14	9	4	......	4	......	12	5	8	9	9	6	80
Cherries	......	......	......	......	108	117	104	......	......	......	......	......	329
Cranberries	......	......	......	......	......	1	......	......	......	......	1	......	2
Fruit	......	......	......	......	......	2	......	......	......	......	......	......	2
Garlic	12	12	31	20	5	8	19	24	37	14	15	5	202
Grape Fruit	22	13	31	15	14	11	8	8	12	8	16	15	173
Grapes	32	5	......	......	......	......	36	57	74	119	74	32	429
Horse Radish	......	......	1	2	......	......	......	......	......	1	1	1	6
Lemons	37	7	40	25	37	45	31	29	45	41	28	33	398
Megs	3	......	......	......	......	33	50	28	38	35	7	7	191
Nectarines	......	......	......	......	......	15	18	......	......	......	......	......	33
Nuts	......	......	......	5	......	......	......	......	......	......	8	12	25
Onions	240	346	182	99	87	25	242	367	358	688	348	387	3,259
Oranges	818	453	912	500	227	819	549	847	398	111	518	1,063	6,715
Parsnips	......	......	......	......	......	......	......	......	1	......	1	......	2
Peaches	......	......	......	......	......	218	117	55	67	10	......	......	467
Rhubarb	......	......	......	......	4	3	4	......	......	......	......	1	12
Pears	......	......	......	......	......	4	60	45	41	30	15	15	210
Persimmons	......	......	......	......	......	......	......	......	......	5	88	5	98
Plants	9	6	15	6	13	3	......	4	3	......	1	......	60
Plums	......	......	......	......	......	149	157	45	45	16	......	......	412
Pomegranates	......	......	......	......	......	......	......	......	3	38	38	......	79
Quinces	......	......	......	......	......	......	......	......	......	2	......	......	2
Seeds	10	4	8	4	9	1	......	12	......	4	......	......	52
Potatoes	916	761	1,406	460	905	318	384	592	843	1,328	802	825	9,585
Squash	......	......	......	......	......	......	1	......	......	......	......	......	1
Tangerines	214	185	112	40	25	......	6	......	......	......	......	175	707
Tomatoes	......	......	......	......	......	......	1	......	......	......	......	......	1
Turnips	......	3	8	5	2	2	3	......	......	2	3	2	29
Vegetables	4	5	9	7	6	4	4	1	1	3	3	8	55
Total	3,298	2,202	3,522	1,391	2,196	2,018	2,167	2,068	2,442	3,286	3,040	3,762	31,377

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Apples	4	7	5	1	5	3	......	......	7	1	1	5	39
Asparagus	6	5	......	1	4	2	2	......	......	......	......	......	20
Bamboo Shoots	......	......	......	1	2	......	......	......	......	......	......	......	3
Beans	......	248	10	115	101	100	40	30	101	294	68	......	1,107
Chestnuts, Water	47	28	9	65	10	15	12	4	......	21	36	51	298
Caladiums	......	42	......	......	......	......	......	......	......	......	......	......	42
Carrots	......	......	......	......	......	......	32	26	......	......	......	......	58
Chestnuts, Gr.	......	......	......	......	......	......	......	......	51	......	......	......	51
Cocoanuts	......	......	......	......	......	4	......	8	......	......	......	......	12
Corn	......	......	1	......	......	......	2	......	......	......	......	......	3
Fruit	2	3	1	......	......	2	......	......	5	......	1	......	14
Garlic	9	2	4	8	4	7	21	17	7	3	1	11	94
Grape Fruit	......	1	1	1	4	3	5	3	2	......	......	......	20
Horse Radish	6	4	1	2	2	1	1	......	2	......	1	......	20
Lemons	......	1	......	1	......	1	......	......	......	......	1	2	6
Limes	......	......	......	......	......	1	......	......	......	......	......	......	1
Gingers	34	2	11	21	4	7	20	20	53	8	9	23	212
Nuts	4	1	6	......	2	2	5	......	1	5	......	4	30
Onions	2	4	137	2	10	1	4	4	2	5	......	......	171
Oranges	10	10	9	3	8	7	4	5	4	......	3	4	67
Peas	......	......	......	3	......	......	......	......	......	......	496	366	865
Parsnips	......	......	......	......	......	......	1	......	......	......	......	......	1
Wheat	......	......	......	......	411	......	......	......	700	302	......	......	1,413
Peanuts	114	50	136	20	......	175	103	146	166	30	......	......	940
Pears	......	......	......	......	......	......	......	......	......	......	......	1	1
Persimmons	......	......	......	......	......	......	......	......	......	......	2	......	2
Plants	15	4	47	54	23	4	99	......	201	1	880	68	1,396
White Nuts	8	7	......	......	......	......	......	......	......	1	4	......	20
Pomelo	......	1	......	......	......	......	......	......	......	......	4	2	7
Seeds	100	119	110	51	29	49	140	57	142	35	154	20	1,006
Sand Pears	2	5	1	1	3	2	4	5	3	1	......	......	27
Potatoes	1	40	......	2	1	......	......	3	1	......	......	......	48
Sweet Potatoes	5	6	6	8	......	1	9	2	4	......	4	......	45
Tangerines	12	7	11	2	......	......	......	......	......	......	4	4	40
Taro	1	......	1	......	......	......	......	......	......	......	2	......	4
Yams	59	18	4	42	15	......	29	25	37	3	26	34	292
Vegetables	2	6	......	1	8	......	......	1	......	3	......	......	21
Trees	......	......	......	......	......	13	......	......	......	......	......	......	13
Bulbs	8	2	......	1	1	......	......	......	......	......	11	7	30
Total	451	623	511	406	647	400	583	356	1,489	713	1,708	602	8,489

APPENDIX NO. 8.

FRUITS AND VEGETABLES RECEIVED IN HILO DURING 1917.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Apples	873	375	765	161	776	42	291	392	472	808	1,029	1,153	7,132
Apricots	......	......	......	......	......	181	46	......	......	......	......	......	227
Artichokes	......	1	1	5	......	1	......	......	1	2	2	1	13
Beans	62	47	24	19	......	......	......	25	......	20	18	10	225
Cabbage	......	......	......	......	......	1	1	1	1	......	......	1	5
Asparagus	......	......	......	......	......	......	1	......	......	......	......	1	2
Cauliflower	27	21	28	18	24	26	25	3	9	7	15	4	207
Celery	14	9	4	......	4	......	12	5	8	9	9	6	80
Cherries	......	......	......	......	108	117	104	......	......	......	......	......	329
Cranberries	......	......	......	......	......	1	......	......	......	......	1	......	2
Fruit	......	......	......	......	......	2	......	......	......	......	......	......	2
Garlic	12	12	31	20	5	8	19	24	37	14	15	5	202
Grape Fruit	22	18	31	15	14	11	8	8	12	8	16	15	178
Grapes	32	5	......	......	......	......	36	57	74	119	74	32	429
Horse Radish	......	......	1	2	......	......	......	......	......	1	1	1	6
Lemons	37	7	40	25	37	45	31	29	45	41	28	33	398
Megs	3	......	......	......	......	33	50	23	33	35	7	7	191
Nectarines	......	......	......	......	......	15	18	......	......	......	......	......	33
Nuts	......	......	......	5	......	......	......	......	......	......	8	12	25
Onions	240	346	132	99	37	25	242	367	353	683	348	387	3,259
Oranges	818	453	912	500	227	819	549	347	393	111	518	1,068	6,715
Parsnips	......	......	......	......	......	......	......	......	1	......	1	......	2
Peaches	......	......	......	......	......	218	117	55	67	10	......	......	467
Rhubarb	......	......	......	......	4	3	4	......	......	......	......	1	12
Pears	......	......	......	......	......	4	60	45	41	30	15	15	210
Persimmons	......	......	......	......	......	......	......	......	......	5	88	5	98
Plants	9	6	15	6	13	3	......	4	3	......	1	......	60
Plums	......	......	......	......	......	149	157	45	45	16	......	......	412
Pomegranates	......	......	......	......	......	......	......	......	3	38	38	......	79
Quinces	......	......	......	......	......	......	......	......	......	2	......	......	2
Seeds	10	4	8	4	9	1	......	12	......	4	......	......	52
Potatoes	916	761	1,406	460	905	318	384	592	843	1,323	802	825	9,535
Squash	......	......	......	......	......	......	1	......	......	......	......	......	1
Tangerines	214	135	112	40	25	......	6	......	......	......	......	175	707
Tomatoes	......	......	......	......	......	......	1	......	......	......	......	......	1
Turnips	......	3	8	5	2	2	3	......	......	2	3	2	29
Vegetables	4	5	9	7	6	4	4	1	1	3	3	8	55
Total	3,293	2,203	3,522	1,391	2,196	2,018	2,167	2,068	2,442	3,286	3,040	3,762	31,377

APPENDIX NO. 9.

FRUITS AND VEGETABLES RECEIVED IN HILO DURING 1918.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Apples	429	276	106	385	379	21	33	640	415	1,142	984	1,158	5,968
Apricots	......	......	......	......	......	6	16	......	......	......	......	......	22
Artichokes	1	1	2	1	2	3	1	1	......	2	......	1	15
Beans	29	......	......	55	80	164	42	11	58	67	63	10	524
Cabbage	......	......	......	......	......	......	......	......	......	2	......	1	3
Asparagus	......	1	1	2	2	10	......	......	......	......	......	1	17
Cauliflower	6	......	2	6	4	4	5	11	5	9	......	4	56
Celery	3	6	3	4	......	1	4	9	4	28	......	6	68
Cherries	......	......	......	......	......	20	6	......	......	......	......	......	26
Garlic	8	5	4	14	5	4	20	22	16	9	3	5	115
Grape Fruit	7	9	11	9	9	13	11	12	11	16	2	15	125
Grapes	......	......	......	......	......	......	20	12	82	79	89	32	314
Horse Radish	......	......	......	......	......	......	......	......	......	......	......	1	1
Lemons	16	7	5	16	9	28	19	24	25	6	6	33	194
Megs	......	......	......	......	......	2	18	30	......	8	......	7	65
Nectarines	......	......	......	......	......	......	......	7	......	......	......	......	7
Nuts	......	......	......	......	......	2	......	5	1	......	8	12	28
Onions	307	169	143	319	361	380	527	443	608	251	311	387	4,206
Oranges	558	281	284	270	189	287	305	288	90	43	24	1,063	3,682
Peas	......	1	2	4	2	6	1	10	2	......	......	......	28
Peaches	......	......	......	......	......	3	8	58	68	44	......	......	181
Rhubarb	......	1	2	2	1	......	1	......	......	......	......	1	8
Pears	5	......	......	......	......	......	16	14	16	18	8	15	92
Persimmons	......	......	......	......	......	......	......	......	......	30	......	5	35
Plants	1	1	4	......	2	1	1	......	......	3	......	......	13
Plums	......	......	......	......	......	......	26	63	16	3	......	......	108
Pomegranates	......	......	......	......	......	......	......	......	......	20	41	......	61
Seeds	......	......	......	12	13	5	5	4	......	2	......	......	41
Potatoes	1,155	882	817	972	885	1,502	1,228	728	381	680	1,305	825	11,255
Tangerines	25	30	24	19	......	......	......	......	......	......	15	175	288
Tomatoes	......	......	......	......	1	2	......	3	......	......	......	......	6
Turnips	8	2	4	......	1	3	2	2	2	2	2	2	28
Vegetables	1	1	2	2	1	3	1	2	......	1	......	8	22
Total	2,554	1,628	1,416	2,092	1,896	2,470	2,816	2,844	1,795	2,415	2,861	3,762	27,644

APPENDIX NO. 10.

FRUITS AND VEGETABLES RECEIVED IN KAHULUI DURING 1917.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Apples	127	139	124	101	74	1	45	85	165	195	274	309	1,639
Apricots	......	......	......	......	......	16	8	......	......	......	......	......	24
Artichokes	2	1	2	2	2	3	1	......	......	......	......	1	14
Beans	......	......	......	......	1	2	......	1	......	......	......	......	4
Cauliflower	12	11	11	12	8	13	6	3	5	7	5	......	93
Celery	13	1	1	5	4	9	6	6	11	13	8	......	77
Celery Root	2	1	......	1	......	......	......	1	......	......	......	......	5
Cherries	......	......	......	......	7	50	34	6	......	......	......	......	97
Cranberries	......	......	......	......	......	......	......	......	......	......	2	......	2
Fruit	......	......	......	......	......	10	11	1	......	......	......	......	22
Asparagus	2	2	......	2	1	1	......	......	......	......	......	......	8
Garlic	4	2	3	3	2	10	1	2	7	3	3	......	40
Grape Fruit	4	5	6	7	4	10	6	3	9	3	2	7	66
Grapes	......	......	......	......	......	......	6	5	24	38	46	2	121
Lemons	3	7	15	7	7	15	10	2	9	10	10	12	107
Megs	......	......	......	......	......	7	16	10	8	14	2	......	57
Onions	115	45	8	27	4	......	20	20	77	47	93	63	519
Oranges	127	129	114	117	251	357	212	97	98	130	107	150	1,889
Parsnips	2	......	......	......	......	......	......	......	......	......	......	......	2
Peas	......	......	......	4	3	1	......	1	......	......	......	......	9
Peaches	......	......	......	3	......	13	35	13	40	18	......	......	122
Rhubarb	1	4	2	3	3	5	3	......	2	3	......	......	26
Pears	24	12	1	1	......	......	10	15	36	34	31	......	164
Persimmons	......	......	......	......	......	......	......	......	......	......	4	......	4
Plants	......	......	......	......	......	2	......	......	......	......	......	......	2
Plums	......	......	......	......	......	16	31	10	26	16	......	......	99
Prunes	......	......	......	......	......	10	......	4	......	......	......	......	14
Sprouts	1	3	......	......	......	......	......	......	......	......	......	......	4
Potatoes	135	141	13	75	45	69	24	32	259	175	110	198	1,276
Squash	......	1	......	......	......	......	......	1	......	......	......	......	2
Tangerines	......	......	......	......	......	......	......	......	......	......	......	20	20
Turnips	3	3	4	2	3	6	8	2	1	3	......	......	35
Trees	......	2	......	......	......	......	......	......	5	......	2	......	9
Vegetables	4	2	1	1	2	3	......	1	1	......	......	......	15
Total	581	511	305	373	421	629	493	321	782	710	699	762	6,587

APPENDIX NO. 11.
FRUITS AND VEGETABLES RECEIVED IN KAHULUI DURING 1918.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Apples	301	147	90	60	145	......	5	50	55	135	195	143	1,326
Apricots	......	......	14	......	......	5	4	......	......	......	......	......	23
Cauliflower	3	1	1	......	2	3	1	......	......	......	......	......	11
Celery	2	1	1	1	......	......	......	......	......	......	......	......	5
Cherries	......	......	......	......	20	12	18	......	......	......	......	......	50
Rhubarb	......	......	......	......	......	......	1	......	......	......	......	......	1
Garlic	3	......	......	......	10	8	8	......	......	......	......	......	29
Grape Fruit	2	5	3	4	9	5	8	5	2	4	6	5	58
Grapes	5	......	......	......	......	......	......	......	......	......	......	......	5
Lemons	6	4	2	2	8	5	8	5	1	4	10	5	60
Megs	......	......	......	......	......	5	4	......	......	......	......	......	9
Onions	169	98	53	14	85	84	89	8	......	95	158	33	876
Oranges	185	107	89	52	182	101	41	68	......	11	5	33	824
Peas	......	......	1	......	......	......	......	......	......	......	......	......	1
Peaches	......	......	......	......	......	3	20	......	......	......	13	......	36
Pears	4	......	......	......	......	......	1	......	......	14	8	......	27
Plants	......	4	1	......	1	......	......	......	......	......	......	......	6
Plums	......	......	......	......	......	......	10	......	......	......	......	......	10
Potatoes	327	89	69	52	261	476	126	8	......	82	130	95	1,665
Tangerines	......	......	......	......	......	......	......	......	......	......	......	5	5
Total	1,007	451	324	185	673	707	344	144	58	295	520	319	5,027

APPENDIX NO 12.
INTER-ISLAND INSPECTION
1917

Month	Vessels Inspected	PASSED Fruit	PASSED Plants	PASSED Vegetables	PASSED Total	REJECTED Fruit	REJECTED Plants	REJECTED Total	Total Inspected
January	71	16	137	805	958	4	16	20	978
February	63	3	111	738	852	5	4	9	861
March	58	8	189	760	957	9	8	17	974
April	61	17	190	614	821	3	5	8	829
May	62	11	180	641	832	4	6	10	842
June	58	17	184	827	1,028	5	6	11	1,039
July	64	26	103	695	824	3	4	7	831
August	59	20	242	714	976	3	3	6	982
September	58	20	108	711	839	2	4	6	845
October	60	23	207	886	1,116	3	7	10	1,126
November	57	18	218	868	1,104	11	7	18	1,122
December	54	11	119	924	1,054	8	4	12	1,066
Total............	725	190	1,988	10,188	11,861	60	74	134	11,495

INTER-ISLAND INSPECTION
1918

Month	Vessels Inspected	PASSED Fruit	PASSED Plants	PASSED Veg's.	PASSED Total	REJECTED Fruit	REJECTED Plants	REJECTED Total	REJECTED Cane Sugar	Inspected Total
January	58	14	164	752	930	2	....	2	....	932
February	52	22	65	861	948	....	2	2	....	950
March	52	13	141	969	1,123	3	8	11	....	1,134
April	52	13	177	1,062	1,252	....	2	2	....	1,254
May	61	16	184	979	1,179	4	3	7	....	1,186
June	58	19	162	951	1,132	3	3	6	....	1,138
July	57	63	85	854	1,102	1	6	7	....	1,009
August	47	341	73	817	1,231	2	3	5	100*	1,336
September	58	12	106	868	986	7	5	12	....	998
October	61	162	62	870	1,094	2	3	5	....	1,099
November	58	82	101	881	1,064	4	9	13	....	1,077
December	57	144	97	509	750	4	20	24	....	774
Total..........	671	851	1,417	10,428	12,691	37	59	96	100	12,887

*Rejected

APPENDIX NO. 13.

TERRITORY OF HAWAII

BOARD OF COMMISSIONERS OF AGRICULTURE AND FORESTRY.

RULE I. DIVISION OF PLANT INSPECTION.

The Board of Commissioners of Agriculture and Forestry of the Territory of Hawaii hereby amends Rule I of the Board concerning the importation or introduction into the Territory of Hawaii of fresh fruit from East or West Indies, Asia, Australia, Ocanica, Malaysia, Mexico, Central and South America, approved by the Governor of Hawaii on October 25, 1904, so as to read as follows and to be known as Rule I—Division of Plant Inspection:

Section 1. For the purpose of preventing the introduction into the Territory of Hawaii of fruit flies and insects, their eggs, larvae or pupae, and all diseases of plants, fruits or other vegetation of value, all persons, companies and corporations are hereby prohibited from introducing, importing or bringing in baggage or otherwise into the Territory of Hawaii, or into any of its ports for the purpose of debarkation into the said Territory, any fresh fruit from East or West Indies, Asia, Australasia, Oceanica, Malaysia, Mexico, Central and South America.

Section 2. All plants, cuttings, scions, buds, bulbs, roots or tubers, seeds, grains or cereals may be imported into the Territory of Hawaii from any foreign country; provided, however, that permission has been granted by the Federal Horticultural Board of Washington, D.C., and that such permit has been received by the Chief Plant Inspector of the Territory. All plants, cuttings, scions, buds, bulbs, roots or tubers, seeds, grains or cereals, including those from the mainland of the United States, are subject to inspection upon arrival into the Territory of Hawaii. All persons and corporations are hereby prohibited from removing or taking any of the above articles from a wharf or landing place without first having notified the Division of Plant Inspection of the arrival of said article or articles and having received permission from the duly authorized officer to remove or take the same.

Section 3. All fruits, vegetables, plants, parts of plants, bulbs, roots or tubers, seeds, grains or cereals from the United States of America and the Dominion of Canada that are not prohibited under rules and regulations of the Federal Horticultural Board of Washington, D.C., may be introduced, imported or brought into the Territory of Hawaii either by freight, express or as packages of passengers, provided, however, that all such fruits, vegetables, plants, parts of plants, bulbs, roots, seeds, grains and cereals are free from pests and diseases. All persons importing, introducing or bringing into the Territory of Hawaii any fruits, vegetables, plants, or parts of plants, bulbs, roots or tubers, seeds, grains and cereals must present the same to or notify the Chief Plant Inspector of the Board of Agriculture and Forestry before landing any of these articles.

Section 4. If any fresh fruits vegetables, plants, cuttings, scions, buds, bulbs, roots or tubers, seeds, grains, or cereals shall be imported, introduced or brought in baggage or otherwise, into the Territory of Hawai, or into any of its ports for the purpose of debarkation into said Territory, contrary to law or this regulation, the same shall, in the discretion of the Board of Commissioners of Agriculture and Forestry or its duly authorized agent, officer or inspector, be immediately seized and destroyed or deported at the expense of the importer or introducer, and the person or persons or corporation introducing or importing the same shall be guilty of a misdemeanor and shall be liable to the penalty or penalties provided by law.

Section 5. This rule, as amended, shall take effect upon its approval by the Governor.

Approved this 8th day of June, 1918.

LUCIUS E. PINKHAM,

Honolulu, T.H. Governor of Hawaii.

APPENDIX NO. 14.

TERRITORY OF HAWAII

BOARD OF COMMISSIONERS OF AGRICULTURE AND FORESTRY.

RULE III. DIVISION OF PLANT INSPECTION.

The Board of Commissioners of Agriculture and Forestry of the Territory of Hawaii hereby amends Rule III of the Board concerning the importation of rice, approved by the Governor of Hawaii on September 7, 1906, so as to read as follows and to be known as Rule III—Division of Plant Inspection:

Section 1. For the purpose of preventing the introduction into the Territory of Hawaii of insects, their eggs, larvae or pupae, and fungus diseases, injurious or liable to become injurious to rice either growing or stored, all persons, companies and corporations are hereby prohibited from introducing or importing into the Territory of Hawaii or into any of its ports, any rice infested with such insects.

Section 2. For the purpose of preventing all rice shipments from Japan for entry into the Territory of Hawaii from being infested with insects, their eggs, larvae or pupae, or fungus diseases, injurious or liable to become injurious to rice, all shippers are required to have their shipment fumigated at the port of debarkation in Japan under government supervision and before placing same on board the vessel, and all shipments must be accompanied with a certificate of fumigation signed by the proper authorized person.

Section 3. If any rice infested with insects, their eggs, larvae or pupae, injurious to rice, growing or stored, shall be imported or introduced into the Territory of Hawaii or into any of its ports, the same shall, in the discretion of the Board of Commissioners of Agriculture and Forestry, or its duly authorized agent, officer or inspector be immediately destroyed or deported at the expense of the importer or introducer, and the person or persons or corporation introducing or importing the same shall be guilty of a misdemeanor and shall be liable to the penalty or penalties provided by law.

Section 4. This rule, as amended, shall take effect upon its approval by the Governor.

Approved this 8th day of June, 1918.

LUCIUS E. PINKHAM,

Honolulu, T.H. Governor of Hawaii.

APPENDIX NO. 15.

TERRITORY OF HAWAII

BOARD OF COMMISSIONERS OF AGRICULTURE AND FORESTRY.

RULE XIX. DIVISION OF PLANT INSPECTION.

Rule and Regulation of the Board of Commissioners of Agriculture and Forestry concerning the Introduction of Pineapple Plants, Suckers, Sprouts, or Fruit.

The Board of Commissioners of Agriculture and Forestry of the Territory of Hawaii hereby makes the following Rule and Regulation:

Section 1. For the purpose of preventing the introduction into the Territory of Hawaii of serious pests and diseases of the pineapple plant, all persons, companies and corporations are hereby prohibited from introducing or importing or receiving as freight and express matter or from bringing or receiving in baggage or otherwise into the Territory of Hawaii or into any of its ports for the purpose of debarkation into said Territory any pineapple plant, sucker or sprout or fruit from the West Indies, Central America, including the Panama Canal Zone, or any other locality where said serious pests and diseases exist or may become known to exist.

Section 2. Any person or persons or corporation violating the above rule shall be guilty of a misdemeanor, and upon conviction thereof shall be punished by a fine not to exceed Five Hundred ($500.00) Dollars, as provided by Section 529, Revised Laws of Hawaii of 1915.

Section 3. This rule shall take effect upon its approval by the Governor.

Approved this 8th day of June, 1918.

LUCIUS E. PINKHAM,

Honolulu, T.H.

Governor of Hawaii.

Division of Animal Industry

LETTER OF SUBMITTAL

Honolulu, Hawaii,
December 31, 1918.

The Board of Commissioners of
Agriculture and Forestry,
Honolulu, Hawaii.

Gentlemen: I beg to submit herewith a report on the work of the Division of Animal Industry for the biennial period ending December 31, 1918.

The first chapter, under the heading "Introduction," contains a concise resume of the whole and has been written with a view to furnishing the main facts to the legislators and others who may have many reports to acquaint themselves with in a short time. The reports of the deputy territorial veterinarians, with the exception of the one from Dr. Elliot of East Hawaii, have not been given in detail as they pertained principally to the anthrax outbreaks and are referred to under that heading. The assistant territorial veterinarian, Dr. L. N. Case, has written the chapter on Bovine Tuberculosis Control.

Respectfully submitted,

VICTOR A. NORGAARD,
Territorial Veterinarian.

Report of the Territorial Veterinarian

INTRODUCTION

The work of the Division of Animal Industry has during the past two years differed from that of the preceding decade in that it had to be devoted to combatting a disease hitherto unknown in the Territory, and which for a while threatened the entire local live stock industry, namely *Anthrax*. For the first time in the twelve years of its existence this Division had to deal with a real epidemic of a virulent malignant disease, fatal to man and beast and the introduction of which remains a mystery to this day. The total absence of a natural source of infection and the inexplicable manner in which it jumped from Kauai to Oahu and Maui leaves, however, little doubt that the propelling force behind it was of Hun origin.

That the Legislature was in session at the time and promptly provided liberal means wherewith to fight the outbreak accounts in no small way for the effectiveness with which the onslaught was met. On both Kauai and Oahu the disease was kept confined—by stringent quarantine measures—to the premises where it first made its appearance, and there is little reason to doubt that the seven outbreaks on Maui, though widely scattered, were planted simultaneously or at least within a couple of days, and were independent of each other.

It is of course to be regretted that the actual perpetrators of this outrage were not brought to justice, at least in so far as this specific crime is concerned, but there is reason to believe that the dragnet applied to local alien enemies caught at least one of them.

In any case, with a loss of less than five hundred head of cattle and horse stock the epidemic was brought to a complete standstill on Oahu and Maui before the fall of 1917, while only two cases have occurred on Kauai during 1918, and the last one of these more than seven months ago.

This does not mean that the infection is eradicated, but is due to the vaccination of all animals in infected pastures. Under favorable conditions the infection may remain active or alive in the soil for years, if not permanently, and preventive measures (vaccination) and constant vigilance must be continued for an indefinite period. A single anthrax carcass left unburned is sufficient to cause a destructive outbreak. The coming Legislature will therefore be asked to provide for the continuation of these preventive measures.

Another divergence from previous years' methods has been the bovine tuberculosis control work, under the indemnification act passed by the last Legislature. This act appropriated $20,000.00 for the indemnification of owners of tuberculous cattle destroyed for the purpose of eradicating this disease from the Territory.

While this Division has persisted in suppressing bovine tuberculosis as an infectious and contagious disease transmissible to man, and especially to children, ever since 1910, it was not until the passage of the above mentioned act, with its very liberal compensation provisions, that the opposition of the dairy owners can be said to have subsided and the prospects of complete eradication to have come within reach. That this policy was sound has been borne out by subsequent legislative action on the part of most of the states in the Union and is now finally corroborated by the federal government volunteering to share the losses resulting from tuberculosis eradication work.

The 1919 agricultural appropriation bill just passed by Congress provides for the payment by the federal department of agriculture of one-third of the difference between the appraised value of the condemned cattle and the salvage value of the carcass, provided that the State, county or municipality where the cattle are kept or owned is cooperating with the tuberculosis work and pays at least an equal amount to the owner. In other words, when this bill becomes effective here, the Territory will save about one-third of the compensation now being paid, but what is far more important is that the highest authority has endorsed the policy which the Board of Agriculture and Forestry had adopted before any other state or territory in the Union had attempted it in any way but tentatively. At the present writing the bill, as passed, omits the word "Territory", mentioning only States, counties and municipalities, which, according to advice received from Washington, bars this Territory from participating in the appropriation ($500,000.00). The next Congress, however, meeting March 4th, 1919, will undoubtedly continue this policy of partial indemnification by the federal government, when it is expected that this unfortunate omission of the Territory will be corrected.

That we are entitled to participate in this benevolent appropriation is assured in a letter from the Chief of the Bureau of Animal Industry, a paragraph of which reads:

"Hawaii not being a State we could not indemnify owners in cooperation with the Territory, but it seems as if we might pay indemnities in cooperation with the various counties of Hawaii provided cooperative arrangements could be made with those units of government."

There being no county appropriations nor county organizations to handle the tuberculosis control work, a complete reorganization of all live stock sanitary matters, including the expenditure of territorial appropriations by county officials, would have to be effected in order to make the Territory benefit by the federal act. Such an arrangement, if it were at all possible, could be effected only by legislative action and would be required only for the remaining couple of months of the fiscal year ending June 30, 1919. In the meantime, the territorial delegate to Congress will take the matter up in Washington and will undoubtedly succeed in having the said act either amended or corrected.

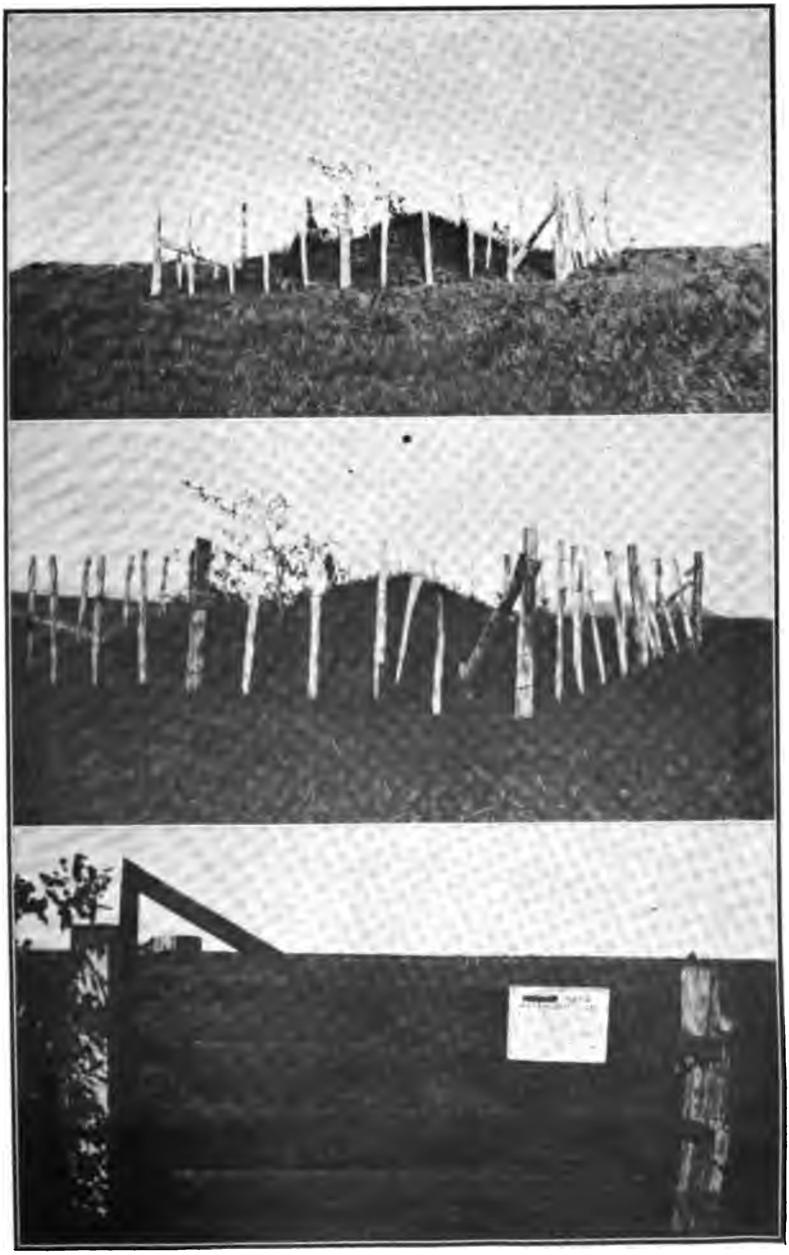
Under authority of Act 121 of the Session Laws of 1917, this Division has tested 9,577 head of cattle, of which number 453 were found to be affected with tuberculosis. The condemned cattle were appraised at an aggregate of $40,265.00, or an average of $98.93 per head. After slaughter and inspection the wholesome parts of the carcasses were sold for $17,674.66, or an average of $44.52 per head. The owners consequently received a total of $83.76 per head, or more than eighty per cent of the appraised value, as by law provided for.

It will therefore be seen that there remained about $4,000.00 unexpended at the end of the calendar year 1918.

Altogether this law has given general satisfaction and when it is considered that all of the condemned animals were diseased and a menace to the healthy animals in the herds from which they were removed, and further, that a majority of them were unprofitable as milk producers and either were or might become at any time dangerous to human beings, then it cannot be disputed that the Territory has paid liberally for the privilege of destroying these centers of infection.

In fact, a comparison with the amount of indemnification allowed by most of the states which have not inaugurated tuberculosis eradication campaigns, a total of forty on December 1st, 1918, shows the amounts allowed by this Territory are far above the average. On the other hand, it must be conceded that dairy cattle are more valuable here than anywhere else in the Union, and that it costs a great deal more to maintain them here and to produce milk. No other state or community allows an indemnity of $150.00 per head, plus the value of the carcass, except for purebred registered animals. But even so, the fact remains that the dairy industry has had a severe setback through the excessive war prices of all feeds. Only the thrifty oriental, who produces and delivers his milk through unceasing work on the part of himself, his family and relatives, seems satisfied with the small margin of profit which a bunch of low grade cows, fed principally

Plate 9.



Mounded, Fenced-in, and Tree-planted Graves of Anthrax Carcasses on Kauai. Many of them contain eight carcasses. Lower shows quarantine signs placed on all pasture gates in infected district.

on honohono, affords these days. Still he is always cheerful about having his cows tested and rarely buys an animal without consulting this office as to when such an animal was last tested and if it is safe to buy it without a retest.

In regard to the general prevalence of bovine tuberculosis in the Territory, the indemnification act under discussion brought to light an unlooked for number of cases which caused the percentage of reactors for the year 1917 to mount to 7.09%, which, however, was again reduced to 3.03% for 1918.

It may therefore be expected that the continuation of the tuberculosis eradication work for another two years will see the end of the infection in the Territory, and also that the amount of indemnification required will be much smaller from now on. With one-third to one-half of this being paid by the federal department of agriculture, it should not be necessary to ask the next Legislature for more than one-half the sum provided by the last Legislature; otherwise, it might be better if the Legislature should decide upon an increase in the amount of appraisal, as has been recommended.

Beyond anthrax and tuberculosis the Territory has been singularly free from animal diseases of any kind during the past period.

The splendid development of mule breeding, of which the Parker Ranch has made such a signal success, has been dealt with in the report of the deputy territorial veterinarian for East Hawaii. His surmises that this ranch will be able in the near future to supply all the mules required by the local agricultural industries and thereby do away with the costly and unsatisfactory importation of mules from the mainland are no doubt correct.

The same ranch has also taken the lead in breeding up its beef cattle and is now in a position to supply high class purebred Hereford sires to the cattle men of the Territory.

As far as dairy cattle are concerned, an entirely too limited number of breeding stock has been brought in to make any kind of impression upon the dairy industry in general. Only a well situated ranch or large farm, which would take up the raising and selling of purebred dairy cattle and not allow dairying per se to crowd the young stock off the premises, could save the dairy industry of the Territory from going all to pieces. It costs little more to raise a dairy animal than a beef animal and the profits should be better, besides affording the satisfaction of helping the babies of the Territory along until they can eat beef. Good bulls may be imported by individual dairies but that does little good if the owners cannot afford to raise the calves—which is the rule. And a stunted purebred is no better than a pure brindle which started life better equipped to hustle for a living.

Swine raising has improved steadily, both as to quality and quantity. Many splendid breeding animals are now owned here and the razor back has practically disappeared. This industry will take care of itself now it is so well started.

The sheep industry is gradually being crowded out by the cattle and the demand for mutton also seems to be decreasing. Only the Parker Ranch continues to keep up the qualities of its wool and mutton by annual importation of high class rams from New Zealand.

Poultry (frozen) and eggs are imported in steadily increasing quantities, the high cost of feed having driven many of the small poultry men out of business. In 1918 about one-tenth of the live poultry imported in 1917 arrived here. This is, however, purely a war condition that will right itself with easier access to feed.

IMPORTATIONS OF LIVE STOCK

The following classes of live stock have been received at the ports of Honolulu and Hilo during the years 1917 and 1918.

Port	Year	Horses	Mules	Cattle	Sheep	Swine	Dogs	Cats	Poultry (cts.)
Honolulu	**1917**	**245**	**244**	**272**	**68**	**24**	**67**	**21**	**489**
Hilo	**"**	**12**	**95**	**23**	**0**	**10**	**0**	**0**	**30**
Honolulu, ...	**1918**	**9**	**81**	**190**	**50**	**13**	**43**	**4**	**57**
Hilo	**"**	**1**	**69**	**0**	**0**	**0**	**0**	**0**	**5**
Grand Total............		**267**	**489**	**485**	**118**	**47**	**110**	**25**	**581**

Horses

There was an increase in the number of horses imported during the last biennial period. The importations consisted mainly of plantation work stock. A number of fine thorough-bred mares and two fine stallions were imported by Mrs. Walter McFarlane.

Mules

The importation of mules has decreased considerably during the last two years. That the large ranches on Hawaii are able to supply the major portion of the demand for this class of live stock is a credit to the animal industry of this Territory and shows what may be expected in other classes of live stock.

Cattle

Importations of cattle have more than doubled in the last two years. The following classes were represented:

Holsteins: 23 bulls, 318 cows.
Jerseys: 3 bulls, 17 cows.
Herefords: 44 bulls, 14 heifers.
Shorthorns: 29 bulls.

There were exceptional individuals in all classes.

Sheep

Importations in this class were confined to Merinos, Shropshires, and Southdowns. One hundred fine New Zealand Merino rams went to the Parker Ranch for the continued improvement of their stock.

Swine

The small number of swine imported consisted of Berkshires, Hampshires and Duroc-Jerseys, all pure-bred high class breeding stock. The exhibits at the last Territorial Fair gave evidence of the great improvement such importations are making on the class of stock now being raised.

Poultry

There has been a notable decrease in the number of crates received here in the last two years. During 1915-1916 over three thousand crates of poultry were imported, the majority being for the various markets. The poultry now being imported are mostly for breeding purposes and egg production.

NEW RULES AND REGULATIONS PERTAINING TO THE IMPORTATION OF LIVE STOCK.

A great deal of legislation pertaining to live stock in interstate and foreign trade has been enacted by Congress, as well as by a majority of the States during the past few years. It was therefore deemed advisable to bring the local importation regulations up to date, and a complete revision of the old rules, which had been in effect since January, 1910, was decided upon. The new rules which were promulgated in June, 1918, follow:

TERRITORY OF HAWAII.

BOARD OF AGRICULTURE AND FORESTRY—DIVISION OF ANIMAL INDUSTRY.

REGULATIONS GOVERNING THE IMPORTATION OF LIVE STOCK AND OTHER ANIMALS INTO THE TERRITORY OF HAWAII.

(Effective June 8, 1918.)

Under authority of Sections 503 to 509 inclusive of the Revised Laws of Hawaii, 1915, the Board of Commissioners of Agriculture and Forestry issue the following regulations, the same to supersede all previous regulations on the same subject and to become effective upon approval by the Governor.

RULE I.—DEFINITION OF TERMS.

Whenever in these regulations the following words, names or terms are used they shall be construed as follows:

Animals. This word refers particularly to pets, zoological, menagery or wild animals, whether mammals, birds, reptiles or fishes, as distinguished from domestic animals, or live stock, and poultry.

Domestic Animals or Live Stock. These words refer to horses, mules, asses, cattle, sheep, goats, swine, dogs and cats.

Horses or Horse Stock refer to horses, mules and asses.

Poultry refers to chickens, ducks, turkeys, pigeons, guinea hens, peacocks, etc.

Inspector or Inspecting Officer. These words, unqualified, refer to veterinary officers, as the Territorial Veterinarian, the Assistant, and Deputy Territorial Veterinarians.

Live Stock Inspector refers to lay Inspectors .

Transmissible Diseases. These words apply to all infectious, contagious or communicable diseases of animals.

Territorial Veterinarian also refers to and includes the Assistant Territorial Veterinarian and the Deputy Territorial Veterinarians at the various ports of entry.

The above definitions are not intended to be exclusive.

RULE II.—GENERAL PROVISIONS.

All importations of live stock and other animals into the Territory of Hawaii from foreign countries are subject to the Regulations of the United States Department of Agriculture and permit for such importations must be obtained from Washington, D.C., by application through the office of the Territorial Veterinarian in Honolulu.

All importations of live stock from the mainland of the United States into the Territory of Hawaii are subject to the regulations of the United States Department of Agriculture governing the humane handling and safe transport of live stock in interstate trade, and permit to so carry stock must be obtained for each and every shipment from the proper federal official at the port of shipment.

RULE III.—INSPECTION OF IMPORTED LIVE STOCK.

Sec 1. In order to prevent introduction into this Territory of infectious, contagious and communicable diseases among live stock and other animals, local managers or agents of steamship and navigation lines or the commanding officer of any ship, shall notify the Territorial Veterinarian immediately upon the arrival of any ship, of the presence on board, if any, of live domestic animals, including poultry and dogs, when same are intended to be landed in this Territory, and shall upon arrival of any ship furnish the inspecting officer with a list of the number and kind of animals taken on board from any port outside of this Territory, the number and kind destined for the Territory, the names of the owners or consignees, and a report as to the condition of health and cases of sickness or death and the causes thereof among the animals while on board.

Sec 2. If necessary to remove such animals before the arrival of the inspector they must be confined on the pier in such a manner as to facilitate inspection, but shall in no case be turned loose on the pier. Hogs and sheep shall be confined in temporary pens or crates. Cattle and horses shall be tied on the pier. No animal of any description shall be allowed to leave the pier until the Territorial Veterinarian has issued a certificate of health permitting the landing of the animal or animals in question.

Sec. 3. In no case shall the removal of live animals from the ship for inspection or other purposes, constitute an entry into the Territory until a certificate of health for such animals has been issued.

RULE IV.—HORSES, MULES AND ASSES

Sec. 1. All horse stock intended for importation into the Territory of Hawaii must be accompanied by a certificate of health, issued or approved by a veterinary officer of the United States Bureau of Animal Industry, to the effect that the animals in question (tailtagged or otherwise identified), have been tested with mallein within two weeks prior to shipment and have been found free from symptoms of glanders, farcy or any other transmissible disease.

Sec. 2. All horse stock arriving in the Territory of Hawaii and coming from or through the State of California shall be quarantined at the port of entry for a period of twenty-one days counting from the date of departure from California.

Sec. 3. By "quarantine" shall be understood the absolute segregation of such animals, on premises provided or approved by the Territorial Veterinarian.

Sec. 4. If at the end of the stipulated period the Territorial Veterinarian is not satisfied that the animals are free from glanders or other contagious diseases, the same shall be either subjected to the mallein test or continued in quarantine, or both, until released and admitted to this Territory.

Sec. 5. All expenses in connection with the quarantining of horse stock as above specified shall be borne by the owner, importer or consignee.

RULE V.—CATTLE FOR BREEDING AND DAIRY PURPOSES.

Sec. 1. All cattle six months old or over intended for importation into the Territory of Hawaii must be accompanied by a certificate of health issued or approved by a veterinary officer in the United States Bureau of Animal Industry or by the State Veterinarian for the state or district where the cattle in question are located, to the effect (a) that the animals are free from bovine tuberculosis as proved by the tuberculin test and (b) that they have not been in contact, directly or indirectly, with any cattle not proven by the tuberculin test to have been free from tuberculosis for at least one year prior to date of shipment.

Sec 2. All cattle conforming with "a" of Sec. 1, but failing to qualify for "b" may be landed in quarantine and held for re-test and further disposal by the Territorial Veterinarian, as by law provided for animals that have been exposed to infection.

Sec. 3. Calves less than six months old and not accompanying their dams must be accompanied by a certificate issued or approved as in Sec. 1 described, and to the effect that they come from tuberculin tested mothers and have not been exposed to the infection of tuberculosis since birth. Otherwise they shall be dealth with as in Sec. 2 provided for.

RULE VI.—SHEEP.

No sheep shall be admitted to this Territory unless accompanied by a certificate of health issued or approved by an officer of the United States Bureau of Animal Industry, and to the special effect that the animals are free from sheep scab and have been shipped in accordance with the regulations of the United States Bureau of Animal Industry governing the transportation of live stock in interstate trade.

RULE VII.—SWINE.

Sec. 1. All swine intended for shipment to the Territory of Hawaii must be accompanied by a certificate of health issued or approved by an officer of the United States Bureau of Animal Industry or by the State Veterinarian, to the effect that the animals have passed a careful veterinary inspection and are free from any indication of disease, and that neither hog cholera nor swine plague has existed within a radius of 5 miles of the premises on which they have been kept for a period of six months immediately preceding the date of shipment.

Sec. 2. The owner or importer must present an affidavit to the effect that the said certificate refers to the swine in question, that the same have been shipped from the premises mentioned in said certificate in clean and disinfected cars, and without unloading and that they have not been submitted to the serum simultaneous or double treatment for hog cholera within thirty days prior to shipment

Sec. 3. Swine arriving in the Territory without such certificate and affidavit shall be subject to a quarantine of two weeks at the expense of the owner or importer.

RULE VIII.—DOGS.

Sec. 1 All dogs arriving in the Territory of Hawaii and coming from or through any country, state or territory, where rabies is known to exist, shall be kept in quarantine, on premises provided by this Board, for a period of 120 days, or for such longer period, not to exceed 180 days, counting from the date of embarkation as, in the judgment of the Territorial Veterinarian, shall be necessary.

Sec. 2. Dogs belonging to tourists or temporary visitors shall be taken to the quarantine station and held there until the departure of the tourist or visitor, when the dog will be delivered on board by the Territorial Veterinarian, all expenses to be paid by the owner, agent or keeper.

Sec. 3. It shall be the duty of the owner, master or agent of any vessel arriving in the Territory of Hawaii to immediately notify the Territorial Veterinarian of the presence on board of any dog, whether intended for disembarkation or not. Such dog must, in the discretion of the Territorial Veterinarian, be removed to the animal quarantine station or confined on board in such a manner as to insure that it does not come in contact with any other dogs or animals which might transmit the disease or rabies.

Dogs which belong to steamers or other vessels, their officers or crew, or other dogs on board such vessels destined for a further port, must be securely confined as directed by the Territorial Veterinarian as long as the steamer or vessel remains in port. No other dogs shall be allowed on board unless intended for exportation, in which case they shall remain on board when once brought there, and must be confined in the same manner as above described.

Sec. 4. Until further notice the port of Honolulu shall constitute the only port through which dogs may enter the Territory. Dogs arriving at any other port must be kept confined on board until arrival at Honolulu, or must depart with the vessel when it leaves the Territory.

Sec. 5. All expenses in connection with the quarantining of dogs entering the Territory must be borne by the owner, agent, keeper, or consignees, and no dog shall be released from quarantine until such costs are paid.

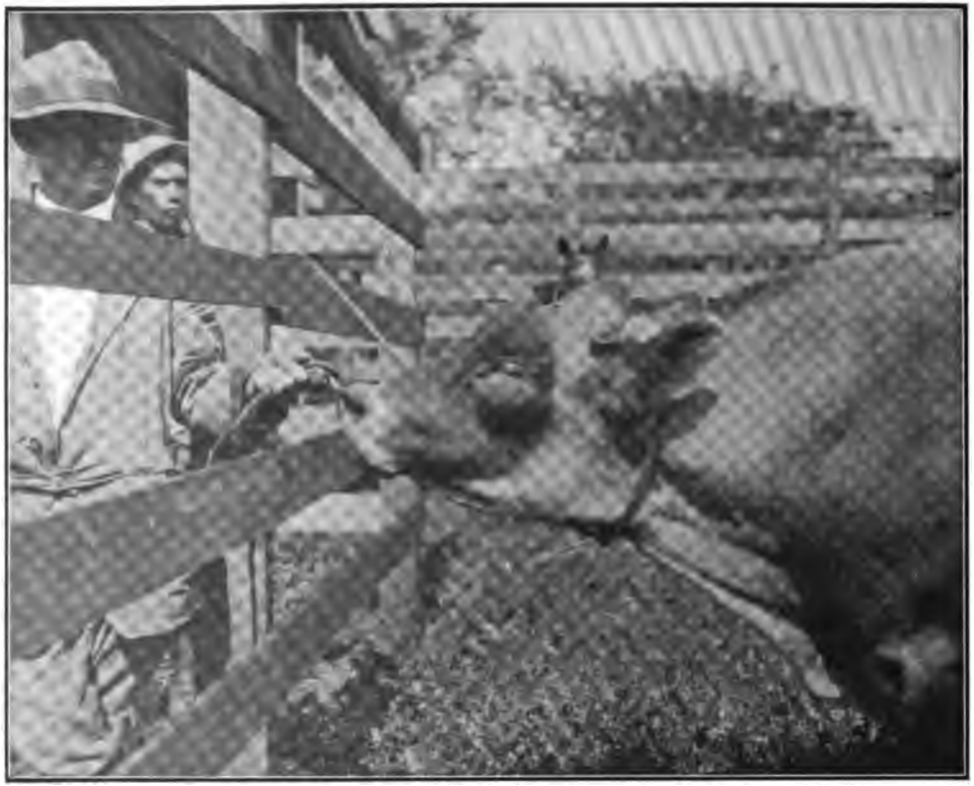
RULE IX.—POULTRY

All live poultry arriving in the Territory shall be held for inspection and be declared on the list of live stock furnished the inspecting officer on the arrival of any steamer or vessel in the Territory. The number of deaths or cases of sickness and causes thereof, while en route, shall also be noted. Until inspected and passed by the Territorial Veterinarian all such poultry must remain on board or be kept confined on the pier awaiting his arrival.

RULE X.—WILD ANIMALS, PETS, MENAGERY AND ZOOLOGICAL GARDEN ANIMALS.

The traffic in this class of animals in regulated by the United

Plate 10.



Purebred Jersey Bull Showing Large Reaction to the Intrapalpebral Tuberculin Test.
The lesions found on autopsy were confined to a few small nodules in both retropharyngeal glands.

States Department of Agriculture, but the Territorial Veterinarian must be notified of the arrival of all such specimens as it is possible for them to carry diseases transmissible to domestic animals and man.

These rules shall take effect upon approval by the Governor.

Approved this 8th day of June, 1918.

LUCIUS E. PINKHAM,
Honolulu, Territory of Hawaii. Governor of Hawaii.

LAWS UPON WHICH THE FOREGOING REGULATIONS ARE BASED.

Extracts from Chapter 37, Revised Laws of Hawaii of 1915, as amended by Section 8 of Act 136 of the Session Laws of 1915.

"Sec. 503. RULES AND REGULATION. Said board of agriculture and forestry shall have power and authority to make rules and regulations, and to amend the same from time to time in its discretion, subject to the approval of the governor, for and concerning the inspection, quarantine, disinfection or destruction, either upon introduction into the Territory, or at any time or place within the Territory, of animals and the premises and effects used in connection with such animals. Included therein may be rules and regulations governing the transportation of animals between the different islands of the Territory and along the highways thereof, and also such rules and regulations as may be approved by the governor requiring the owners and masters of any boat or vessel engaged in inter-island transportation of live stock, and the managers and agents of railway companies craying live stock within the Territory, to make reports of the number and class of live stock carried, names of owners and consignees, the places to and from which such stock is shipped, the manner of handling such live stock, the number of deaths or injuries to live stock occurring in transit or while being loaded or unloaded, with the causes of such deaths or injuries and all other matters which may be deemed necessary by the board for a full and complete record of such shipping and handling of live stock. And also to prohibit the importation into the Territory from any foreign country, or other parts of the United States, or from one island within the Territory to another island therein, or to one locality from another locality on the same island of animals known to be infected with a contagious, infectious or communicable disease or known to have been exposed to any such disease.

"Sec. 504. TERRITORIAL VETERINARIAN. Said board of agriculture and forestry shall have power and authority to appoint a superintendent of animal industry who shall be a competent veterinary surgeon and shall be known as the "Territorial veterinarian."

"He shall have charge, direction and control (subject to the direction and control of the board), of all matters relating to the inspection of animals and the prevention and eradication of contagious, infectious and communicable diseases among animals and of all matters relating to animal industry mentioned in or coming within the scope of this chapter, and such other matters as the board shall from time to time direct. He shall enjoy all the powers, rights, privileges and immunities of an officer of the board of health.

"Sec. 505. LIVE STOCK INSPECTORS. Said board of agriculture and forestry shall have power and authority to appoint and commission one or more live stock inspectors for each judicial circuit and other employees as may be necessary for the proper carrying into effect of the provisions of this chapter and may at its pleasure remove any inspector or employee and fix their compensation.

"Sec. 506. ENTRY OF ANIMALS. No domestic animal shall be allowed to enter the Territory of Hawaii except after inspection by the Territorial veterinarian or in his absence by a live stock inspector, and a permit issued by such inspecting officer to the consignee or owner, provided, however, that no fees for inspection shall be charged, nor delays caused concerning the landing of any domestic animal for which a certificate of health has been issued as prescribed by an act of congress approved February 2nd, 1903, and entitled 'An act to enable the secretary of agriculture to more effectually suppress and prevent the spread of infectious and contagious diseases of live stock and for other purposes.'

"Sec. 507. LANDING NOT AN ENTRY. The landing of any animal for the purpose of inspection or quarantine shall not be construed to be an entry into the Territory for any purpose whatsoever, except as herein provided, and if in the opinion of the inspecting officer it shall be necessary or proper to quarantine any such animal, he shall have authority so to do at the expense of the owner or consignee.

"Sec. 508. QUARANTINE. The board shall have the power to quarantine any domestic animal known to be affected with or to have been exposed to any contagious, infectious or communicable disease, and to destroy the same, when in the opinion of the Territorial veterinarian, or in his absence, a duly qualified veterinary surgeon, such measure is necessary to prevent the spread of such disease, and to provide for the proper disposition of its hide and carcass; and to disinfect premises where any such disease may have existed.

"Sec. 509. MASTER OF VESSEL TO NOTIFY INSPECTORS. The master of any vessel on which there shall have been shipped live animals for any port in this Territory shall immediately, upon arrival, cause the inspecting officers to be notified, and shall not permit the animals to be taken from the wharf or landing, nor any portion of the food or water, nor any effects connected therewith or provided for their use during the voyage, to be removed from the wharf or landing until the inspecting officer shall have inspected and passed the same."

REPEAL OF RULE VII.

Rule VII of this Division which prohibited the transfer of hogs from Oahu to any other island went into effect on July 10, 1913, at a time when hog cholera was prevalent on Oahu and it was necessary to prevent the spread of the disease to the other islands by this quarantine measure.

Since by July, 1917, no case of hog cholera had occurred on Oahu for more than a year, this rule seemed no longer necessary and on the recommendation of the Territorial Veterinarian it was accordingly repealed by the following notice:

NOTICE OF REPEAL OF RULE VII.

Notice is hereby given that Rule VII of the Division of Animal Industry prohibiting the shipment, transfer, or exchange of hogs from the Island of Oahu to any other island of the Territory, adopted by the Board of Commissioners of Agriculture and Forestry and approved by the Governor of Hawaii on July 10, 1913, is hereby repealed and declared to be no longer in effect.

Approved this 28th day of July, 1917.

LUCIUS E. PINKHAM,
Governor of Hawaii.

RABBITS AND BELGIAN HARES.

The 1917 Legislature passed a law (Act 50) forbidding the keeping and breeding of rabbits or Belgian hares in the Territory, except on permit issued by this Board. In accordance with this law, which principally aims at keeping these animals confined and thereby preventing them from becoming pests, a new rule (Division of Animal Industry, Rule XIII) was approved by the Governor on October 30, 1917, since which date 112 permits to keep and breed rabbits have been issued.

The law and regulations follow:

ACT 50

AN ACT

To Repeal Section 544 and to Amend Sections 541, 542 and 543 of the Revised Laws of Hawaii, 1915, Relating to Rabbits and Belgian Hares.

Be it Enacted by the Legislature of the Territory of Hawaii:

Section 1. Section 544 of the Revised Laws of Hawaii, 1915, is hereby repealed.

Section 2. Section 541 of the Revised Laws of Hawaii, 1915, is hereby amended so as to read as follows:

"Section 541. Permit required. The keeping and breeding of rabbits and Belgian hares in the various islands of the Territory is prohibited except upon permit issued by the Territorial Board of Agriculture and Forestry and in accordance with the rules and regulations of said board."

Section 3. Section 542 of the Revised Laws of Hawaii, 1915, is hereby amended so as to read as follows:

"Section 542. Punishment. Any person who shall keep or shall maintain for breeding any rabbits or Belgian hares in any of the islands of the Territory of Hawaii, except as provided in Section 541, as amended, is guilty of a misdemeanor and upon conviction thereof shall be punished by a fine not exceeding one hundred dollars for the first offense, and upon conviction thereof a second time shall be punished by a fine of not exceeding one hundred dollars and imprisonment not exceeding two months."

Section 4. Section 543 of the Revised Laws of Hawaii, 1915, is hereby amended so as to read as follows:

"Section 543. Destruction of unconfined rabbits and Belgian hares. Any police officer or other person is hereby authorized to destroy any rabbit or Belgian hare found unconfined in this Territory, and no officer or other person destroying any rabbits or Belgian hares so found shall be liable for any damages for such destruction to any person claiming the ownership of such animals, provided that no officer or other person shall enter in any inhabited enclosure for the purpose of taking or destroying any rabbits or Belgian hares without authority of law or under a warrant duly issued."

Section 5. This Act shall take effect upon its approval.

Approved this 3rd day of April, A.D. 1917.

LUCIUS E. PINKHAM,
Governor of the Territory of Hawaii.

TERRITORY OF HAWAII

BOARD OF COMMISSIONERS OF AGRICULTURE AND FORESTRY.

RULE XIII. DIVISION OF ANIMAL INDUSTRY.

Rule and Regulation of the Board of Commissioners of Agriculture and Forestry concerning the Keeping and Breeding of Rabbits.

The Board of Commissioners of Agriculture and Forestry of the Territory of Hawaii hereby makes the following rule and regulation pertaining to the keeping and breeding of rabbits in the Territory of Hawaii in accordance with Act 50 of the Session Laws of Hawaii of 1917:

Sec. 1. Every keeper or breeder of rabbits or hares, whether the same are kept singly, as pets or in numbers for their meat, skins, or other purposes, must obtain from the Board of Agriculture and Forestry a permit to keep or breed rabbits.

Sec. 2. In order to obtain such permit it is neecssary for the applicant to submit to the Board of Agriculture and Forestry an affirmed statement to the effect that he will use due diligence and take every possible precaution to the end that such rabbits, for whatsoever purpose kept, remain confined.

Sec. 3. Applicants for permits must obtain from the said Board or its local representative an application blank to be filled in and returned.

This rule shall take effect upon its approval by the Governor of Hawaii.

Approved this 30th day of October, 1917.

LUCIUS E. PINKHAM,
Governor of Hawaii.

Honolulu, T.H.

DISEASES OF LIVE STOCK

ANTHRAX IN THE TERRITORY OF HAWAII.

The year 1917 became remarkable in the Hawaiian live stock annals on account of the first appearance of anthrax among the cattle and horses of the Territory. This fatal disease, which affects all classes of animals, and is transmissible to man, had never been known here before, and as it could not possibly have been brought here by infected animals, the conclusion was reluctantly arrived at that the disease had been introduced and spread maliciously.

The first appearance of the disease occurred on a ranch at Hanalei, on Kauai, and unfortunately a considerable number of animals had died before the diagnosis of anthrax was made and many carcasses had been buried in shallow graves. Serum vaccine was cabled for and pending its arrival every measure was taken to prevent the further spread of the disease. The cattle were then dying at the rate of ten per day, and it soon became evident that nearly all the paddocks on the ranch had been infected, so nothing could be gained by moving the cattle around. A strict quarantine, enforced by guards, was established, and, as soon as received, the entire herd, some 2400 head, were injected with the serum simultaneous anthrax vaccine. Up to this time some 225 animals, mostly cows, had died, and a large force of men was required for burning the carcasses and fencing in the graves of the earlier cases. The vaccination did not stop the losses immediately, so it became necessary to revaccinate the whole herd one month later, when a total of about 300 head had died. The disease had then lasted from the beginning of April and was well under control by the middle of May, though a few scattering cases were observed as late as August.

How the disease was scattered over the ranch is not known to this day. The contents of the salt and bonemeal boxes in the infected pastures were tested by animal inoculations without result. Practically all the paddocks are high and well drained and offer little or no opportunity for the permanent establishment of the anthrax infection. This makes the sudden appearance of the disease in that isolated district so much more remarkable.

However, the end was not yet. During the middle of May, anthrax suddenly made its appearance in a dairy herd almost in the heart of Honolulu. Of approximately 100 milch cows, one-third died in the course of 48 hours. The place was quarantined and the remaining animals were serum vaccinated. In this case the disease was found to have been spread by means of a bag of beet pulp, which was found to be heavily infected with anthrax spores. Only this bag out of a shipment of several hundred proved to be infected, and as the feed room at the dairy was left open at all times, the matter of infecting one of the bags of feed by pouring an anthrax culture over it would meet with little difficulty.

The final surprise came, however, when anthrax was reported from the Island of Maui. There in the course of ten days, during the month of June, no less than seven distinct outbreaks occurred in widely scattered districts. The losses, however, were insignificant, totalling less than fifty head of cattle and horses. Whoever scattered the disease in this case had evidently been in a hurry, as well as being ignorant about how to make the infection do the most damage. As in the other outbreaks, all animals in the infected pastures were immediately serum vaccinated, after which few losses occurred. As all of these outbreaks appeared in pastures contiguous to a highway, it is presumed that the fiend who scattered the disease was traveling in a carriage or automobile, and simply throwing the infected material into the paddocks as he passed them. It is needless to say that by this time the cattle raisers and live-stock owners all over the Islands were thoroughly alarmed and unprecedented measures were adopted to protect the large cattle ranches on Hawaii and elsewhere.

The Territorial Legislature was fortunately in session when the first outbreak of anthrax occurred, and an appropriation of $25,000.00 was made immediately available, with which to fight the disease. Had it not been for this expeditious measure it is doubtful whether the disease could have been suppressed so quickly and completely as was the case.

The serum vaccine used for this purpose is of quite recent origin and would not have been available had the outbreaks happened the year before. Our experience with it has demonstrated it as a valuable preventive and an effective cure in most cases that come under treatment soon enough. It is still rather expensive, costing thirty cents per dose, but it is expected that improved methods of manufacture will greatly reduce this price. A total of 13,000 doses was used, and the results fully justify the expenditure. The greatest item of cost in fighting an anthrax epidemic is the disposal of the carcasses by cremation, and unless this is done, and done thoroughly, there is little likelihood of ever getting rid of the disease, as the anthrax infection can live for years in the ground.

As all the details of the various outbreaks have been published from month to month in the official organ of this Board, it is only necessary to add that the $25,000 appropriation as supplemented later with an additional $1757.00 was expended on the various islands approximately as follows:

Oahu	$8,000.00
Kauai	14,000.00
Maui	4,000.00
Hawaii	1,000.00

To this should be added that the County of Kauai, when the original appropriation was exhausted, contributed at least $3,000.00 and that this Board finally was granted $1500.00 for the continued suppression of the infection on Kauai, from the Governor's contingency fund.

The appended rules, regulations and "By Authority" notices will further illustrate the means whereby the infection was fought and suppressed.

ACT 162

AN ACT

Making an Appropriation for the Control, Suppression and Eradication of the Diseases known as Anthrax and Hemorrhagic Septicemia.

Be it Enacted by the Legislature of the Territory of Hawaii:

Section 1. The sum of twenty-five thousand dollars ($25,000.00) or so much thereof as may be necessary is hereby appropriated from any funds available in the Territorial treasury for the purpose of controlling, suppressing and eradicating in the Territory of Hawaii the acute, infectious and contagious diseases of men and beasts known as anthrax and hemorrhagic septicemia.

Section 2. The amount hereby appropriated shall be immediately available and shall be under the control of and expended by the Board of Commissioners of Agriculture and Forestry.

Section 3. This Act shall take effect upon its approval.

Approved this 27th day of April, A.D. 1917.

LUCIUS E. PINKHAM,
Governor of the Territory of Hawaii.

BY AUTHORITY.

TERRITORY OF HAWAII.

BOARD OF COMMISSIONERS OF AGRICULTURE AND FORESTRY.

RULE X. DIVISION OF ANIMAL INDUSTRY.

Rule and Regulation of the Board of Commissioners of Agriculture and Forestry concerning the quarantine of all domestic animals on the Island of Kauai on account of anthrax and Hemorrhagic Septicemia.

Owing to the fact that diseases known as Anthrax, or Charbon, and Hemorrhagic Septicemia, which affect most classes of domestic animals, and the former of which may be transmitted to man, have made their appearance on the Island of Kauai, it is hereby ordered:

Sec. 1. That there is hereby declared a quarantine of the Island of Kauai, and no domestic or other animal of any class or kind shall be shipped from nor be allowed to leave the Island of Kauai until this quarantine has been lifted by the Board of Agriculture and Forestry.

Sec. 2. That the Territorial Veterinarian shall proclaim special quarantine on such sections of the Island of Kauai where these diseases are prevalent. Such special quarantine to be enforced in accordance with the direction of the Territorial Veterinarian.

Sec. 3. That it shall be the duty of any person, or persons, whether owner of live stock or not, to report without delay the appearance of any kind of disease among live stock to the Territorial Veterinarian, his assistant or deputy, as well as to assist him in every way to locate, control and suppress any and all cases of the diseases in question.

Sec. 4. Any person violating the above rule shall be guilty of a misdemeanor and upon conviction thereof shall be punished by a fine not to exceed five hundred dollars ($500.00), as provided by Sec. 529, Revised Laws of Hawaii of 1915.

This rule shall take effect upon its approval by the Governor of Hawaii.

Approved this 20th day of April, 1917.

LUCIUS E. PINKHAM,
Governor of Hawaii.

Honolulu, T.H.

BY AUTHORITY.

TERRITORY OF HAWAII.

BOARD OF COMMISSIONERS OF AGRICULTURE AND FORESTRY.

RULE XI. DIVISION OF ANIMAL INDUSTRY.

Rule and Regulation of the Board of Commissioners of Agriculture and Forestry concerning the quarantine of all domestic animals on the Island of Oahu, on account of Anthrax and Hemorrhagic Septicemia.

Owing to the fact that diseases known as Anthrax or Charbon, and Hemorrhagic Septicemia, which affect most classes of domestic animals and the former of which may be transmitted to man, have made their appearance on the Island of Oahu, it is hereby ordered:

Sec. 1. That there is hereby declared a quarantine of the Island of Oahu, and no domestic or other animal of any class or kind shall be shipped from or be allowed to leave the Island of Oahu until this quarantine has been lifted by the Board of Agriculture and Forestry, except on a written permit from said Board.

Sec. 2. That there is hereby declared a further quarantine on the area bounded by the following streets and lanes in the District of Honolulu, City and County of Honolulu, Island of Oahu; beginning at the north-east corner of Beretania and Artesian Sts., thence along the east side of Artesian St., thence along the south side of Bingham St.; thence across Metcalf St. and along the northern side of Metcalf St. as far as the College of Hawaii grounds, thence across Metcalf St. and along the eastern side of the lane leading from Metcalf St. at the entrance to the College of Hawaii grounds, in an easterly and southerly direction past the Moilili Rock Quarry to Beretania St. near the junction of King and Beretania Sts, thence along the northern side of Beretania St. to the point of beginning. No domestic or other animal of any class or kind shall be allowed to enter and/or leave the above described district until further notice from the Board of Agriculture and Forestry.

Sec. 3. That the moving or transfer of any dairy animal from one dairy to another or from one pasture to another within the Honolulu District, from Maunalua to Moanalua, is prohibited until further notice from the Board of Agriculture and Forestry.

Sec. 4. That it shall be the duty of any person, or persons, whether owner of live stock or not, to report without delay the appearance of any kind of disease among live stock to the Territorial Veterinarian, his assistant or deputy, as well as to assist him in every way to locate, control and suppress any and all cases of the diseases in question.

Sec. 5. Any person violating the above rule shall be guilty of a misdemeanor and upon conviction thereof shall be punished by a fine not to exceed five hundred dollars ($500.00), as provided by Sec 529, Revised Laws of Hawaii of 1915.

This Rule shall take effect upon its approval by the Governor of Hawaii.

Approved this 25th day of May, 1917.

LUCIUS E. PINKHAM,
Governor of Hawaii.

Honolulu, Territory of Hawaii.

BY AUTHORITY.

NOTICE OF CHANGE IN ANTHRAX QUARANTINE AREA.

Notice is hereby given that, effective at noon on June 5, 1917, the quarantine area described in Sec. 2 of Rule XI of the Division of Animal Industry of the Board of Commissioners of Agriculture and Forestry approved by the Governor on May 25th, 1917, is reduced to the area described as follows:

Beginning at the West corner of Wilder Avenue and Metcalf Street, and running as follows:

1. Northeasterly 765 feet more or less to the Northeast corner of Metcalf and Marques Streets;
2. Easterly 131 feet along Metcalf Street;
3. Southerly 256 feet across Metcalf Street and along the West side of 11 ft. lane;
4. Easterly 11 feet across lane to fence;
5. Southerly 23 feet along fence to stone wall on top of bluff;

6. Southeasterly 190 feet down face of bluff and around base of sloping land to small bridge;
7. Southeasterly 560 feet along ditch along base of sloping land to premises of K. Matsumoto;
8. Southwesterly 40 feet along fence along premises of K. Matsumoto;
9. Southeasterly 117 feet along same;
10. Southwesterly 511 feet more or less along the Northwest side of lane to Beretania Avenue;
11. Northwesterly 1065 feet along the mauka side of Beretania Avenue;
12. Northeasterly 236 feet along fence and cultivated ground to angle in ditch;
13. Northeasterly 630 feet along ditch;
14. Northerly 65 along ditch to a point near base of sloping land;
15. Northwesterly 654 feet along ditch;
16. Northeasterly 172 feet along ditch;
17. Northwesterly 215 feet along ditch and across to the North side of Metcalf Street;
18. Northeasterly 420 feet along Metcalf Street to the initial point.

BOARD OF COMMISSIONERS OF AGRICULTURE AND FORESTRY.

Honolulu, T. H., June 5, 1917.

BY AUTHORITY.

TERRITORY OF HAWAII.

BOARD OF COMMISSIONERS OF AGRICULTURE AND FORESTRY.

RULE XII. DIVISION OF ANIMAL INDUSTRY.

Rule and Regulation of the Board of Commissioners of Agriculture and Forestry concerning the quarantine of all domestic animals on the Island of Maui, on account of Anthrax and Hemorrhagic Septicemia.

Owing to the fact that diseases known as Anthrax or Charbon and Hemorrhagic Septicemia, which affect most classes of domestic animals, and the former of which may be transmitted to man, have made their appearance on the Island of Maui, it is hereby ordered:

Sec. 1. That there is hereby declared a quarantine of the Island of Maui, and no domestic or other animal of any class or kind or their products shall be shipped from or be allowed to leave the Island of Maui until this quarantine has been lifted by the Board of Agriculture and Forestry, or on written permit from said Board.

Sec. 2. That the Territorial Veterinarian or his deputy shall proclaim special quarantine on such sections of the Island of Maui where these diseases may prevail. Such special quarantine to be enforced in accordance with the direction of the Territorial Veterinarian or his deputy.

Sec. 3. That it shall be the duty of any person, or persons, whether owner of live stock or not, to report without delay the appearance of any kind of disease among live stock to the Territorial Veterinarian, his assistant or deputy, as well as to assist him in every way to locate, control and suppress any and all cases of the diseases in question.

Sec. 4. Any person violating the above rule shall be guilty of a misdemeanor and upon conviction thereof shall be punished by a fine not to exceed five hundred dollars ($500.00), as provided by Sec. 529, Revised Laws of Hawaii of 1915.

This rule shall take effect upon its approval by the Governor of Hawaii.

Approved this 13th day of June, 1917.

LUCIUS E. PINKHAM,
Governor of Hawaii.

Honolulu, Territory of Hawaii.

BY AUTHORITY.

NOTICE.

The quarantine placed on the Island of Oahu by Rule XI of the Division of Animal Industry, approved on May 25, 1917, which forbade the shipping of animals from Oahu, is hereby lifted and the other provisions contained in said rule are no longer in effect

BOARD OF COMMISSIONERS OF AGRICULTURE
AND FORESTRY.

Honolulu, October 29, 1917.

BY AUTHORITY.

NOTICE.

The quarantine placed on the Island of Maui by Rule XII of the Division of Animal Industry, approved on June 13, 1917, which forbade the shipping of animals from Maui, is hereby lifted with the exception that a permit must be obtained from the Deputy Territorial Veterinarian for the shipment of animals from infected areas on Maui. The other provisions contained in said rule are no longer in effect.

BOARD OF COMMISSIONERS OF AGRICULTURE
AND FORESTRY.

Honolulu, October 29, 1917.

BY AUTHORITY.

TERRITORY OF HAWAII.—BOARD OF AGRICULTURE AND FORESTRY.

IN RE THE REMOVAL OF THE QUARANTINE GUARDS AT KALIHI-KAI AND HANALEI BRIDGE AND RESTRICTING THE ENTRANCE OF LIVE STOCK INTO THE QUARANTINED AREA.

Section I. Rule X of the Division of Animal Industry, pertaining to Anthrax on the Island of Kauai, with subsequent amendments, remains in force.

Section II. The removal of the quarantine guards from Kalihiwai and Hanalei Bridge does not constitute a removal of the quarantine of the infected district, except as hereinafter specified.

Section III. All fenced and anthrax-infected pastures, enclosures or premises remain quarantined in so far as the admission to them of unvaccinated animals is concerned, and such pastures, enclosures or premises must be kept so fenced as to prevent absolutely entrance of stray live stock from adjoining highways and districts.

Plate 11.

Grade Holstein Heifer Showing Medium-sized Reaction to the Intrapalpebral Tuberculin Test.
Autopsy revealed a few nodules in the diaphragmatic lobe of the right lung and posterior mediastinal gland.

Section IV. All gates opening on public roads or non-infected premises shall be securely fastened and be provided with a sign forbidding the admission of unvaccinated live stock to anthrax-infected districts, and stating the penalty for the violation of the rules and regulations governing the same.

Section V. The Kalihi-kai and Kalihiwai districts, and the public highway leading from the latter to Hanalei bridge, shall be considered free from anthrax infection and no longer quarantined after the date these regulations become effective; but the local representative of this Board shall restablish such quarantine, in full or in part, whenever in his opinion it becomes advisable.

Section VI. The removal of the vaccinated live stock in the quarantined district shall be in direct charge of the local representative of this Board, who shall in each case decide upon and superintend the application of such precautionary measures as he may deem requisite to prevent spread of infection.

Section VII. It shall be the duty of any person to report without delay to the local representative of this Board the sickness or death of any animal in or near the infected district, as well as the presence of any unvaccinated live stock in the quarantined area.

Section VIII. It shall be unlawful for anyone, directly or indirectly to transfer or carry from any pasture, enclosure or premises, where an animal has died from anthrax, or where deaths of animals have occurred which might be attributed to anthrax, any soil, sod, earth, grasses, grass seed, grass roots or any other substance which might possibly carry the infection of anthrax.

Section IX. These rules shall go into effect on August 26th, 1918.

By direction of the Board of Agriculture and Forestry.

VICTOR A. NORGAARD,
Territorial Veterinarian.

Any violation of these rules is punishable by a fine not to exceed $500.00 (Section 529, R.L.H. 1015).

BOVINE TUBERCULOSIS CONTROL.

During the last biennial period considerable progress was made in the eradication of bovine tuberculosis. Less tuberculosis was found in those dairies known to be heavily infected than at any time in their previous history. This is indeed encouraging and with the help of recent regulations by this Board relative to the importation of cattle from other countries and a most liberal indemnification act passed by the 1917 Territorial Legislature, we may look forward to the complete eradication of this disease from the dairy herds of the Territory in a reasonable period of time.

The revised regulations of this Division, governing the importation of live stock and other animals into this Territory contain the following important rule:

"Rule V. Cattle for Breeding and Dairy Purposes.

"Sec. 1. All cattle six months old or over intended for importation into the Territory of Hawaii must be accompanied by a certificate of health issued or approved by a veterinary officer in the United States Bureau of Animal Industry or by the State Veterinarian for the state or district where the cattle in question are located, to the effect (a) that the animals are free from bovine tuberculosis as proved by the tuberculin test, and (b) that they have not been in contact, directly or indirectly, with any cattle not proven by a tuberculin test to have been free from tuberculosis for at least one year prior to date of shipment.

"Sec. 2. All cattle conforming with 'a' of Sec. 1, but failing to qualify for 'b' may be landed in quarantine and held for re-test and further disposal by the Territorial Veterinarian, as by law provided for animals that have been exposed to infection.

"Sec. 3. Calves less than six months old and not accompanying their dams must be accompanied by a certificate issued or approved as in Sec. 1 described, and to the effect that they have come from tuberculin tested mothers and have not been exposed to infection of tuberculosis since birth. Otherwise they shall be dealt with as in Sec. 2 provided for."

The strict enforcement of this regulation will compel importers to buy cattle from tuberculosis-free accredited herds or else submit to the quarantine and retesting of their stock upon arrival, with all the expense connected therewith. The length of such quarantine period will depend primarily upon the amount of disease present in the herd or herds from which such animals originate.

Through the quarantine and testing of all cattle from suspicious herds, sources of infection from the outside will be eliminated which will materially aid in the eradication of tuberculosis from this Territory.

The enforcement of such a regulation may well be considered an indirect aid to the Federal Bureau of Animal Industry in its efforts to eradicate the disease from the United States and to establish tuberculosis-free herds especially in the Pacific Coast States.

LEGISLATION AIDING BOVINE TUBERCULOSIS CONTROL AND ERADICATION.

The 1917 Territorial Legislature passed the following act for the indemnification of owners of condemned tuberculous cattle:

ACT 121.

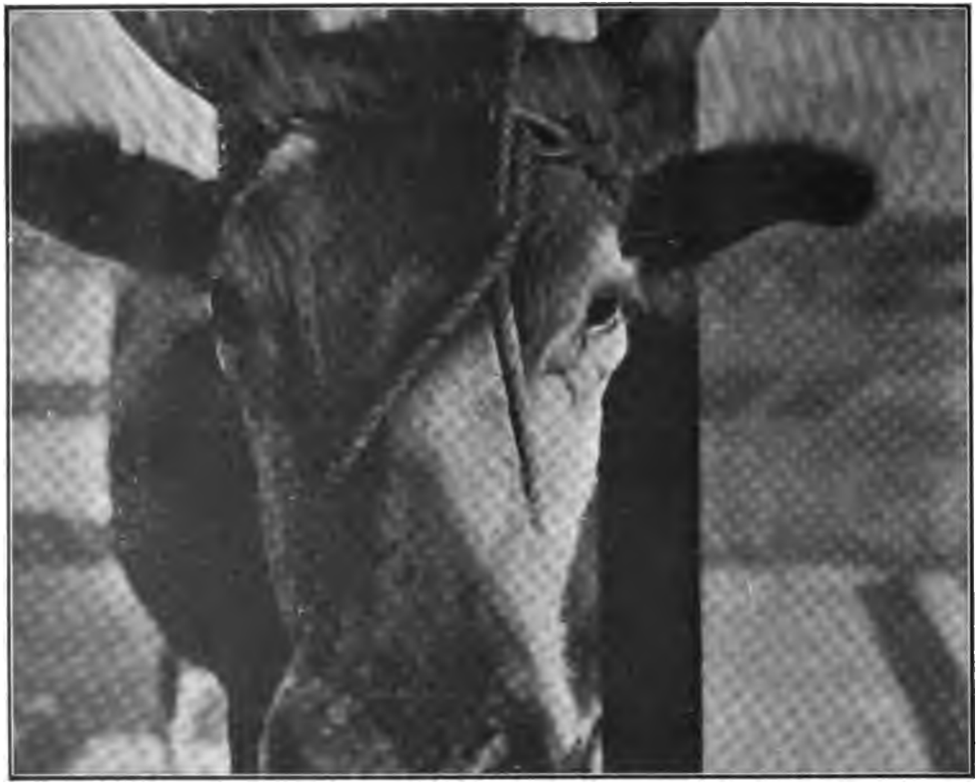
AN ACT

TO PREVENT, SUPPRESS AND ERADICATE BOVINE TUBERCULOSIS AND TO PROVIDE FOR THE INDEMNIFICATION OF OWNERS OF CATTLE DESTROYED UNDER THE PROVISIONS OF THIS ACT.

Be it Enacted by the Legislature of the Territory of Hawaii:

Bovine tuberculosis, a disease transmissible to human beings, and especially to children, through the consumption of milk from tuberculous cows, being prevalent in the Territory of Hawaii, the board of commissioners of agriculture and forestry is hereby authorized and empowered to take the following measures for the prompt prevention, suppression and eradication of bovine tuberculosis:

Plate 12.



Purebred Jersey Heifer Showing Small Reaction to the Intrapalpebral Tuberculin Test. Autopsy revealed lesions of tuberculosis in both retropharyngeal glands, all lobes of the lungs and the mediastinal and left bronchial glands.

Section 1. All dairy cattle within this Territory more than six months old, shall be tuberculin-tested, and when found to be affected with bovine tuberculosis, either upon physical examination or by means of the tuberculin test shall be branded on the left cheek with the registered brand "T.R.," and segregated in a manner satisfactory to the said board, and shall be slaughtered within a time and place designated by an officer of the board, under the supervision of the territorial veterinarian, his assistant or deputy; and the carcass of any such animal shall be disposed of according to the meat inspection regulations of the U. S. Bureau of Animal Industry.

Section 2. All such cattle shall be appraised before being slaughtered, the owner to be indemnified as hereinafter provided for.

Section 3. The president of the board of agriculture and forestry shall designate an appraiser who by and with the advice of the territorial veterinarian, his assistant or deputy shall appraise each tuberculous animal within five days prior to the date of slaughter, basing the amount upon the class and market value of the animal at the time of the appraisal, whether for breeding purposes or for meat or milk production. Animals reacting to the tuberculin test, but not exhibiting any physical evidence of tuberculosis shall be appraised without considering the presence of a diseased condition, but animals exhibiting physical evidence of tuberculosis shall be appraised as diseased animals.

Section 4. The amount of indemnification shall in no case exceed one hundred and fifty dollars for each animal, and all payments thereof shall be made upon vouchers approved by the president of the board of agriculture and forestry; provided, that no payment shall be made for an animal which has been in the Territory for a period of less than six months prior to the date of slaughter.

Section 5. If the amount of appraisal of any animal, as determined by the appraiser designated, is not satisfactory to the owner, he may protest against the same, whereupon a board of three appraisers is to be formed, one of whom shall be designated by the president of the board of agriculture and forestry, one to be selected by the owner, and the third to be selected by these two. The value of the animal to be appraised decided upon by these three appraisers, or by two of them, shall be regarded as final.

Section 6. Compensation for all appraisers appointed or selected pursuant to this Act, shall not exceed five dollars per diem, and such compensation and their necessary travelling expenses shall be paid upon vouchers approved by the president of the board of agriculture and forestry.

Section 7. Following the appraisal of the tuberculous animals the amount of reimbursement shall be determined in accordance with the results of the post mortem inspection as follows:

(a) If any animal is found upon post mortem examination not to be affected with tuberculosis, the carcass and other edible portions shall be passed for food and the owner shall sell the same including all accompanying parts at a fair market price which price shall be deducted from the amount of appraisal and the balance, if any, thus remaining, shall be paid as hereinafter provided.

(b) If any animal is found upon post mortem examination to be affected with tuberculosis and the lesions are such that the carcass and parts are passed for food, the owner shall sell the same at a fair market price which price shall be deducted from eighty per cent of the appraised value and the balance, if any, thus remaining, shall be paid as hereinafter provided for.

(c) If any animal upon post mortem examination is condemned for offal the owner shall sell the hide at a fair market price which price shall be deducted from fifty per cent of the appraised value and the balance, if any, thus remaining, shall be paid as hereinafter provided for.

Section 8. Any premises upon which there have been kept animals affected with tuberculosis shall be disinfected promptly after the removal of such animals and in a manner satisfactory to the territorial veterinarian, his assistant or deputy, at the expense of the owner.

Section 9. The sum of twenty thousand dollars ($20,000.00) is herewith appropriated for the purpose of this Act.

Section 10. This Act shall take effect upon its approval.

Approved this 23rd day of April, A.D., 1917

LUCIUS E. PINKHAM,

Honolulu, Territory of Hawaii. Governor of Hawaii.

The above act became law on April 23, 1917, and went immediately into effect.

Since becoming effective 407 condemned cattle on the island of Oahu have been slaughtered in accordance with its provisions. Of this number, compensation was paid on 372. No compensation was paid on 35, as the beef value was in excess of 80% of the appraised value.

The following figures give the amounts of the appraised value, beef value and indemnification:

1917.

No. Condemned	Total Appraisal Value	Total Beef Value	Total Compensation
407	$40,265.00	$17,674.66	$14,596.75

The above figures show that the dairymen have received from the Territory and the butchers a total of $32,271.41 for their condemned tuberculous cattle, or an average of $83.76 a head; in other words, 84.6% of the average appraised value.

To this Territory belongs the credit of having the most liberal indemnification law to be found anywhere in the United States. Through its provisions this government has materially aided the dairymen in their efforts to clean up their herds and in the main this aid has been appreciated. Still it cannot be said that all opposition to the tuberculin test has ceased. However, as those who most consistently opposed the passage of this measure and who have placed every difficulty in the way of our efforts to eradicate bovine tuberculosis have not been at all backward in demanding the utmost compensation for their condemned animals when forced to have their herds tested, we are confident that all opposition to measures now in force will soon cease.

RESULTS OF THE 1917-1918 TUBERCULIN TEST.

Investigations relative to the prevalence of tuberculosis among the dairy cattle of the City and County of Honolulu carried on during the biennial period ending December 31, 1918, have revealed some very interesting data concerning the amount of the disease still present, the amount of disease brought in from abroad, despite the required tuberculin test certificate before importation, and the efficiency of the method of testing in use here.

During the period under review, a total of 9,577 head of dairy stock were tested, out of which number 9,124 were passed as free from disease and 453 condemned as tuberculous. The percentage of tuberculosis for the entire period was found to be 4.73% Of the 453 condemned cattle only 3 remain alive. They are now segregated and are being conditioned for slaughter.

Below is given a tabulation of the 1917 and 1918 tests:

1917

No. of dairies tested	45	
" " " with no reactors	25	
" " cattle tested	4,004	
" " " passed	3,720	
" " " condemned	204	
Percentage of tuberculosis		7.09%
New dairies tested	15	
" " with no reactors	13	
No. of cattle tested	124	
" " " condemned	5	

1918

No. of dairies tested	133	
" " " with no reactors	96	
" " cattle tested	5,573	
" " " passed	5,404	
" " " condemned	169	
Percentage of tuberculosis		3.03%
New dairies tested	50	
" " with no reactors	39	
No. cattle tested	422	
" " condemned	18	

The high percentage of tuberculosis noted in 1917 would seem to indicate an increase of the disease among the dairy herds, but this apparent increase was due to the outbreak of anthrax which occurred in that year and which put a stop to tuberculin testing for some time, consequently this work was confined principally to those dairies known to be infected.

That this is the correct interpretation of this high percentage is evidenced by the results of a more complete test made the following year, 1918, which brought the percentage of tuberculosis down to 3.03%. A still further decrease would have been noted if the thousand or more range dairy stock at Kahuku had been tested and had it not been for a large number of dairy cattle imported from tuberculous herds on the mainland, which when tested here proved to be diseased.

On the island of Hawaii, Dr. H. B. Elliot reports that a total of 1,308 head of cattle in 343 dairies were tested during the biennial period, out of which number 1,271 were passed and 37 condemned and branded, the percentage of reactors being 2.7%.

All of the above reactors have been slaughtered. Twenty-eight head being condemned after Act 121 went into effect were slaughtered under the provisions of said act. The total appraised value, beef value and compensation paid were as follows:

No. Condemned	Appraisal Value	Beef Value	Compensation Paid
28	$2,365.00	$1,120.47	$848.01

The owners received a total of $1,968.48 (beef value and compensation) for their condemned cattle, or an average of $70.30 per head, which price represents 83.2% of the average appraised value.

Dr. Elliot has found the indemnification act of great assistance in his tuberculosis work. To quote from his report on the subject:

"Although the actual amount of compensation paid to owners is not large, the introduction of this factor into the work of administration has been of remarkable assistance. The cooperation of the owner in work of this nature is an indispensable element of success, and one which can only be secured by fair treatment. No complaints have been received in regard to appraisals or the amount of compensation, and it appears to be generally recognized that the provisions of the act are equitable in these respects."

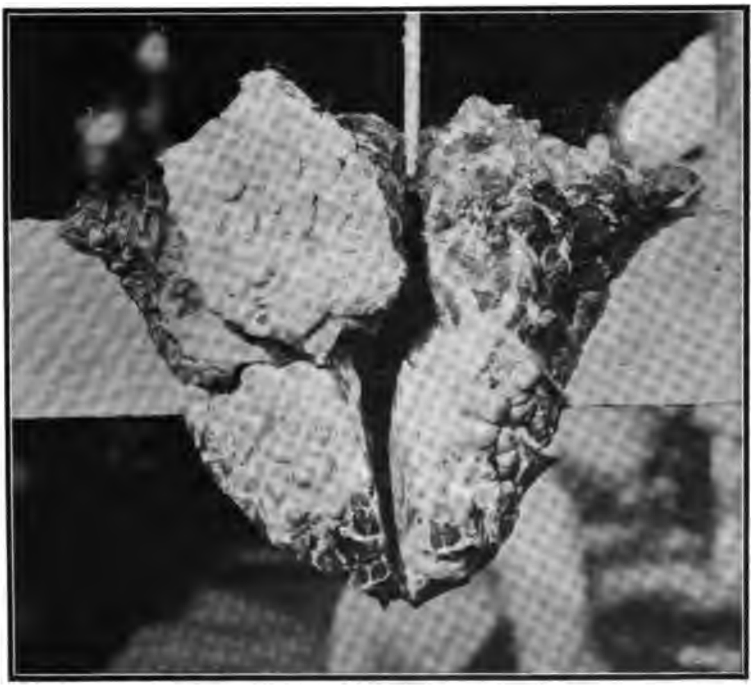
On the island of Kauai the tuberculosis control work was confined to the testing of one dairy herd in which 12 head were condemned, branded and slaughtered, the owner being indemnified in the sum of $387.78. That a better showing was not made on this island was due in part to the severe outbreak of anthrax which occurred in 1917 and which engaged the entire time of the veterinarian stationed there.

Practically nothing has been accomplished in tuberculosis eradication on the island of Maui during the period under review, which is due largely to the work of eradicating anthrax which appeared in seven distinct outbreaks on that island.

In summing up the work of the Division in eradicating bovine tuberculosis, it may be stated that while this work was hindered to a considerable extent on the islands of Kauai and Maui because of serious outbreaks of anthrax, still satisfactory progress has been made.

A total of 493 tuberculous animals have been eliminated from the dairy herds of the Territory, of which number 447 were appraised and slaughtered under the provisions of Act 121. The owners of these cattle received indemnification in the sum of $15,832.54 and salvage to the amount of $19,091.35, making a total of $34,932.89, an average of a trifle over $78.00 per head.

Plate 13.



Large Masses of Tubercles in the Lungs of the Jersey Heifer Shown in Plate 12.

THE INTRAPALPEBRAL TUBERCULIN TEST.

The ideal tuberculin test is that test which can be easily and quickly applied with the least discomfort to the patient; which has the highest degree of accuracy with the widest limits of application and the results of which can be least easily obscured.

The efficiency of any method of testing depends primarily upon the purity and potency of the tuberculin used. Of equal importance is the technique of the operator, his knowledge of the method used and his ability to judge reactions. On this ability to judge reactions will depend the percentage of autopsies showing positive lesions which percentage will be the deciding factor in the accuracy of the method employed.

This Division has for the past eight years used the intradermal tuberculin test in the control and eradication of bovine tuberculosis, first using the sub-caudal fold as the point of injection following the original French method and later using the palpebral fold of the lower eyelid, a method of intradermal injection original here and now officially recognized by many States.

The many advantages of this method of testing have been dealt with at length in former reports; suffice it to say here that the method has proved itself eminently satisfactory and highly efficient in the detection of tuberculosis and conforms most nearly to the ideal tuberculin test elsewhere described.

A few illustrations including the three types of reactions, i.e., large, medium and small, met with in the intrapalpebral tuberculin test are given with notations describing the extent of the lesions in each case.

RESULTS OF AUTOPSIES ON 411 CONDEMNED CATTLE.

The accuracy of the intrapalpebral tuberculin test can best be illustrated by the results of autopsies made on cattle condemned by this method.

Out of 411 cattle condemned for tuberculosis, 409 revealed positive lesions of the disease on autopsy. In the remaining 2, no such lesions could be demonstrated although in one case all the lymph glands in the body were enlarged to double their normal size.

This gives an error of 0.48%, or in other words, the intrapalpebral tuberculin test has proven accurate in 99.52% of cases. Of course, it is realized that no sweeping assertions regarding the accuracy of any method of testing can be based upon so few examinations, but the number of correct results so far obtained would seem to indicate a high degree of efficiency for this particular method.

The distribution of lesions in the various organs of the body in the 409 positive cases above referred to is as follows:

Right sub-maxiliary gland	4	times
Left sub-maxiliary gland	8	"
Right sub-parotid gland	5	"
Left sub-parotid gland	8	"
Right retro-pharyngeal gland	118	"
Left retro-pharyngeal gland	117	"
Right pre-scapular gland	13	"
Left pre-scapular gland	5	"
Anterior mediastinal gland	121	"
Posterior mediastinal gland	201	"
Right bronchial gland	29	"
Left bronchial gland	29	"
Apical lobe right lung	55	"
Costal lobe right lung	45	"
Diaphragmatic lobe right lung	101	"
Diapragmatic lobe left lung	119	"
Costal lobe left lung	38	"
Apical lobe left lung	41	"
Oesophageal glands	27	"
Costal pleura	19	"
Liver	5	"
Portal glands	12	"
Mesenteric glands	80	"
Sub-lumbar glands	1	"
Right inguinal gland	1	"
Left inguinal gland	1	"
Udder	2	"
Supra-mammary glands	10	"

It will be noticed from the above tabulations that lesions of tuberculosis occurred in the udder and supra-mammary glands in about 3% of cases.

A large number of very valuable museum specimens of tuberculous lesions in various internal organs have been obtained. These are proving of considerable educational value, offering concrete illustrations of various forms of the disease, its wide dissemination throughout the body and the danger it may become to the milk supply.

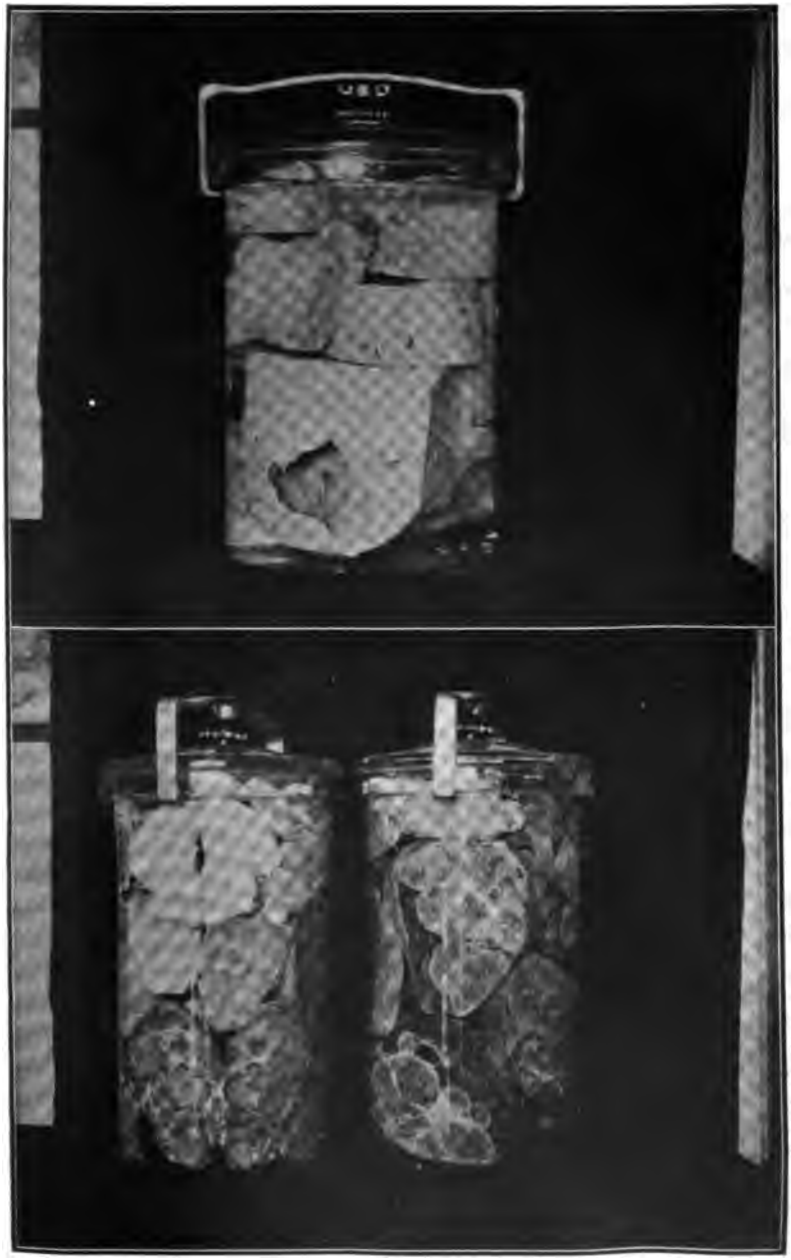
TUBERCULOSIS-FREE ACCREDITED HERDS.

Following the recent policy of the Federal Bureau of Animal Industry in the establishment of tuberculosis-free accredited herds on the mainland of the United States, this Division is now in a position to list 47 dairy herds in the Territory as being free from tuberculosis.

A dairy herd to be listed as an accredited tuberculosis-free herd must have passed successfully two or more annual or semi-annual tuberculin tests. And, furthermore, no herd shall be classified as an accredited herd in which tuberculosis has been found by means of the tuberculin test until such herd has passed successfully two consecutive tests dating from the time of the removal of the last reacting animal or animals.

There are a number of dairy herds in the Territory which have not had a reactor in the past six or seven years as proven by

Plate 14.



Upper Jar: Portions of Udder of Cow Afflicted with Generalized Tuberculosis. The nodules all through this gland can be distinctly seen.

Lower Jar: Specimens of Lungs and Lymph Glands taken from Condemned Tuberculous Cattle, Showing Increased Size of Glands and Lesions.

annual and semi-annual tuberculin tests, and such dairies are entitled to all the benefits accruing from being listed as tuberculosis-free accredited herds.

OTHER LIVE STOCK DISEASES.

With the exception of anthrax and tuberculosis, the live stock of the Territory have been singularly free from infectious diseases during the past year. A few isolated cases of glanders have been reported from the Kohala distrct, but a similar outbreak recently investigated in the Hamakua district proved not to be glanders, but epizootic lymphangitis. Hog cholera seems to have entirely disappeared, and even hemorrhagic septicemia or swine plague is rarely heard of, and still there were more hogs raised in the Territory during the past year than ever before.

Though rabies is still prevalent in the Pacific Coast States, the continued four-months quarantine of all dogs has proved effective in keeping the disease out of the Territory. It became necessary to enlarge the dog quarantine division with twelve additional kennels.

REPORT OF THE DEPUTY TERRITORIAL VETERINARIAN FOR EAST HAWAII

H. B. Elliot, M.R.C.V.S.

GENERAL OBSERVATIONS.

The statistics covering the occurrence of contagious and infectious diseases among the live stock of this district reveal a continuance of the very satisfactory conditions noted in the last biennial report. Particular emphasis is again laid upon the remarkable freedom of our equine live stock from the respiratory diseases of the influenzoid type which have been very prevalent on the mainland and have caused serious monetary losses to the United States and foreign countries. Our own exemption in this respect is undoubtedly the direct and most important result of improved methods of inspection and sanitary regulations.

The Island of Hawaii was fortunate, also, in escaping the outbreaks of anthrax which occurred in 1917 upon other islands of this group. A good deal of alarm was naturally manifested by owners of live stock, and for several months all cases of sudden death attended by suspicious circumstances were reported. Where it was possible, investigations of these cases by field post-mortem and laboratory examinations were made, but in every ease with negative results so far as anthrax was concerned.

During a part of the time covered by this report the writer was absent from the Territory, and the work of the office was conducted, first, by Dr. L. N. Case, Assistant Territorial Veterinarian, and for a later period by Dr. O. B. Shipman, of Hilo.

LIVE STOCK BREEDING AND IMPROVEMENT.

Recent experience has plainly demonstrated the great importance of endeavoring to make these islands self-supporting in the matter of food supplies, and particularly those derived from live stock industry products. Our yearly bill for imported dairy products alone would support comfortably a profitable industry in this Territory. There are great possibilities along these lines, and evidences of successful accomplishment deserve to be recorded.

Horses and Mules. The number of horses in use has been considerably lessened by the universal adoption of automobile transportation, and the principal demand now is for saddle animals for plantation work. There is a plentiful supply of good type animals from the local ranches to meet this demand.

Up to the present time all of the heavier mules required for wagons and field plowing and cultivation on the sugar plantations have been imported from the mainland. Owing to the marked success which has attended the efforts of the Parker Ranch to breed mules of a type suitable for work of this nature this should not be necessary in the future. On the occasion of two visits to this ranch last year I had the pleasure of seeing a large number of four year old mules which compared very favorably in weight and conformation with those imported from abroad. Forty of these mules were purchased by plantations in this district and are reported to be giving excellent satisfaction.

Cattle. The remarkable improvement in the quality of beef cattle produced in all parts of the Territory has been sufficiently demonstrated at the Territorial and County Fairs held during the past few years, and needs no further commendation. This forms a striking contrast to the primitive and inefficient methods of dairying on this island. A large number of milch cows have been killed for their beef value owing to the high price of feed stuffs during the past year. On the face of an increasing population the milk supply in Hilo and the surrounding districts has decreased thirty per cent during the last four years. When it is considered that my estimate in 1914 was that the daily production of milk did not exceed one quart for every ten persons it is evident that the further reduction of this entirely inadequate supply constitutes a very serious problem in a country afflicted with an excessive infant mortality. The high price of feedstuffs is only partly responsible for this falling off in production. The milk business is gradually being monopolized by the industrious alien content with a too small margin of profit. Milk can be produced at the present price of eleven to twelve cents a quart with a small apparent profit, but the margin is too far restricted to cover interest upon capital invested, necessary allowances for depreciation, and maintenance and improvement of the quality of the live stock. Under these circumstances the most serious depreciation is inevitably that of the quality of the livestock. The dairyman, impelled by his own necessity, careless of the future, relies upon bulls of the poorest scrub type to perpetuate his stock. This cannot continue indefinitely because deterioration in the quality of stock is bound to result in increased cost of production. The solution of this phase of the problem depends upon the introduction of good pure bred bulls either by state aid, cooperation among the dairymen, or the establishment by private capital of a modern, well managed dairy upon a scale large enough to provide continuous betterment. Conditions are even less hopeful in the butter making industry. The initial difficulty of providing home grown forage crops has not been overcome, and butter cannot be produced profitably from imported feedstuffs fed to inferior grades of milch cows.

It is proper that a brief reference to the sanitary conditions in the milk dairies should be made. The methods of production, handling, and distribution show a great improvement in recent years. Milk is produced from healthy animals, the methods of milking are reasonably clean, containers are sterilized by boiling, and, so far as can be seen, there is honest compliance with the sanitary regulations. The principal defect lies in the absence of facilities for cooling milk after it is drawn from the cow.

Hogs. Hog raising has not been engaged in on a large scale in this district, although there are a considerable number of owners in a small way of business. From time to time a few pure bred boars and sows of the Duroc-Jersey, Berkshire and Poland-China breeds have been imported, and their influence has gradually improved the quality of the stock.

Poultry. The reviving interest in this industry which was very manifest a few years ago has been almost entirely eliminated by the high cost of feed, and the stock of poultry has been much reduced during the past twelve months. On the other hand, the poultry farm established by Mr. Harold Fisher, at Keaau, Puna, is a notable illustration of successful achievement by the use of sufficient capital combined with efficient and industrious management. Mr. Fisher deserves credit for demonstrating that it is possible in this Territory to establish a large poultry farm with a sufficient egg production to make it commercially profitable, and, further, that by careful attention to hygiene and sanitation the investment can be made a reasonably safe one.

DISEASES OF LIVE STOCK.

Horses and Mules

Endemic Catarrh. A horse brought to Hilo in 1917 from one of the other islands showed symptoms of a mild catarrh. This spread rapidly among the other animals in the stable in which he was confiend, made its appearance in the stables of a neighboring plantation, and was afterwards seen at other more distant points. The outbreak was of a very mild and benign nature, and caused no losses, but the incident is significant because it throws some light upon the transmission of these diseases.

Tetanus. Only three cases of this disease were seen during the period under review.

Cerebro-Spinal Meningitis. For several years the windward coast has been free from this disease, and the only outbreaks that have been noted have occurred in the Kau and South Kohala districts. During this period one case came under my observation.

Osteoporosis. This disease, once very prevalent in the wet districts of Hawaii, has completely disappeared, and no cases have been seen for several years.

Epizootic Lymphangitis. During my absence from the Territory an outbreak of this disease involving a number of animals in the Hamakua district was the subject of investigation by Drs. Norgaard and Shipman.

Cattle

Liver Fluke. In former years this parasite was very rarely seen in this district. Slaughterhouse reports and my own observations convince me that it is now widely distributed among the herds grazing in the pastures running along the edge of the forest reserves on the slopes of Mauna Kea. This constitutes a distinct menace to the large ranches mauka of the forest line, and great care should be exercised in the introduction of fresh stock upon these lands. Where the supply of feed is constant and of sufficient quantity the economic loss from fluke is not excessive, but its presence upon lands subject to occasional drought where feed runs short for several months might easily prove disastrous.

Hogs

Swine Plague. So far as can be ascertained the losses from this source have been comparatively small during the past two years.

HAWAII AGRICULTURAL EXPERIMENT STATION,
J. M. WESTGATE, Agronomist in Charge,
Honolulu, Hawaii.

Under the supervision of the STATES RELATIONS SERVICE,
Office of Experiment Stations, U. S. Department of Agriculture.

REPORT OF THE HAWAII AGRICULTURAL EXPERIMENT STATION.

1919.

Issued September 10, 1920.

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1920.

HAWAII AGRICULTURAL EXPERIMENT STATION, HONOLULU.

[Under the supervision of A. C. True, Director of the States Relations Service, United States Department of Agriculture.]

E. W. Allen, *Chief of Office of Experiment Stations.*

Walter H. Evans, *Chief of Division of Insular Stations, Office of Experiment Stations.*

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L. M. Ross,[2] *Poultry Expert.*

LETTER OF TRANSMITTAL.

Hawaii Agricultural Experiment Station,
Honolulu, Hawaii, July 29, 1919.

Sir: I have the honor to transmit herewith and to recommend for publication a report of the Hawaii Agricultural Experiment Station, 1919.

Respectfully,

J. M. Westgate,
Agronomist in Charge.

Dr. A. C. True,
Director States Relations Service,
U. S. Department of Agriculture, Washington, D. C.

Publication recommended.
A. C. True, *Director.*

Publication authorized.
E. T. Meredith,
Secretary of Agriculture.

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[1] Appointed Apr. 9, 1919, to succeed M. O. Johnson, resigned.
[2] Temporary appointment, Apr. 1 to June 30, 1919.

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REPORT OF THE HAWAII AGRICULTURAL EXPERIMENT STATION, 1919.

SUMMARY OF INVESTIGATIONS.

By J. M. WESTGATE, *Agronomist in Charge.*

INTRODUCTION.

During the past year the energies of the station were largely directed to the most pressing problems of production of food for human beings and feeds for animals. This work in part was successfully carried out by the distribution of seeds, cuttings, and plants to individuals and to public institutions. Improved varieties were given wide distribution, up-to-date cultural methods, including spraying for insects and fungus enemies, and other means used to increase crop yields, were received and adopted to a gratifying degree by the producers. Pleasant cooperative relationship was maintained with the Territorial food commission, and especially with its corps of county agents.

The station continued to emphasize the desirability of increasing the production of diversified crops. It is and has long been fully realized that locally grown diversified crops must compete, to a large extent, with crops imported from the coast. These are often imported at less expense for freight than is paid on similar crops from the other islands of the group. In Hawaii the uneven surface of the land usually devoted to diversified crops and the small size of fields necessarily increase the amount of hand labor required, thereby increasing the cost of production. It is felt, therefore, that too great stress can not be laid on the desirability of having many new kinds of crops produced in considerable quantities so that the agricultural practices necessary to the production of these crops on a large scale could be readily adopted in case any calamity should befall the sugar, pineapple, or banana industries.

Tendencies in the island seem to have been the nonencouragement, rather than the encouragement, of production of diversified food crops. This fact is borne out by the recent failure of the Territorial legislature to make an appropriation for the continuation of the agricultural county-agent system, and likewise by their withdrawal of the customary appropriation from the Territorial marketing division. The latter, during the past seven years, developed from a small beginning to where, in April, May, and June of 1919, it handled $56,249.72 worth of produce and filled a long-felt need for the consumer and small producer. At the time that the county agents were eliminated, provision was made for a sugar-cane expert, at a salary of $500 a month, to advise and assist those raising sugar cane on their homesteads. The Territorial financial support was also withdrawn from the Glenwood substation, it being proposed to transfer the agricultural experimental work of the Territory to the opposite side of the island of Hawaii, where there are larger areas of potential homesteading land suitable for the production of diversified crops. An appropriation was made for the establishment and maintenance of a new station at Waimea, Hawaii; unfortunately, however, the money appropriated was to be supplied from the "loan fund," which, it is claimed, can be used for permanent improvements only and not for the operation of an experiment station. At its last session the legislature authorized the expenditure of $5,000 for farm buildings at the Haleakala demonstration farm. It is planned to construct these buildings in 1920, loan funds having been provided for that purpose.

Although the Territorial legislature saw fit to withhold its support from the Territorial county-agent system, it is universally acknowledged throughout the islands that this method, as developed during the war period, thoroughly demonstrated its efficiency in bringing home to the mixed population of the islands those improvements in agricultural practices deemed desirable for general adoption. The personal contact of the county agent with the tiller of the soil is the most effective means of solving the many difficult problems confronted by the producing classes. It is hoped that subsequent Territorial legislatures will reestablish the Territorial county-agent system to supplement the Federal extension work at present under way.

COOPERATIVE ACTIVITIES.

It has been the policy of the station to undertake work in cooperation with individuals, institutions, and organizations, both public and private, wherever the work in question promised to be of mutual advantage. It was felt that by giving careful attention to the formulation and execution of plans, many projects could be as effectively carried out through the cooperation of such an agency as though the station unaided had undertaken the entire work. Such cooperation would make it possible to provide for many more projects than can be cared for when the entire cost of the work is borne by the station alone.

As specific instances, it should be noted that the station continued to cooperate with representatives of the several military posts throughout the islands, and provided seeds and plants for gardens of the various companies. These gardens, which proved a very valuable adjunct to the needs of the local military establishments, were looked after by specially detailed men from each company, the work usually being assigned to those who showed a decided liking for it. Prizes won at the last two Territorial fairs indicate, in some measure, the success achieved in vegetable raising by the gardeners. The products from each company's garden formed a most welcome addition to the standard Army rations, and, in some instances, the attempts to farm proved so successful that the supply of products obtained exceeded their demand.

The station established an increasing number of cooperative relations with small farmers, and with a number of the larger ranches and plantations. The small grower was provided with such seed and planting material as was found practicable, and all possible information and assistance necessary to further any particular line of his work was furnished him. With larger concerns, the station usually confined its efforts to giving expert advice and assistance in outlining those experiments carried out by the men in charge of the ranch or plantation. Since these experiments sometimes extend over a number of years, those having their immediate oversight must carefully follow them up until the results of a number of seasons have been obtained. It was found, owing to the great diversity in rainfall, altitude, and soil conditions, that experimental results true of one locality may not be true of another, even though separated by only a few miles. For this reason it was desirable to repeat, in the immediate localities where work was to be tried out on a larger scale, those experiments which were successfully carried on by the experiment station. These repetition trials are ordinarily conducted in cooperation with private parties, it not being felt that continual close supervision on the part of the station is as essential as is the case with the regular station experiments.

In addition to the above-mentioned cooperation, the station maintained relations with agricultural societies, chambers of commerce, business men's clubs, and with the trustees of several large estates who are broadly interested in the development of diversified agriculture. The Hawaiian Sugar Planters' Experiment Station, and some of the pineapple, sugar, and banana plantations proved very helpful in a number of cooperative undertakings.

Informal cooperative relations also existed between this and various State experiment stations, and with the several branches of the United States Department of Agriculture at Washington, as well as with the agricultural departments of many foreign countries.

NEED OF SUPPLEMENTARY FOOD CROP INDUSTRIES.

The Hawaiian Islands depend entirely too much upon the sugar industry for their true prosperity, and there is always the possibility that the market price of sugar may fall to such a level that many of the plantations would be forced out of business. There is further a strategic need for the growing of other crops, so that these islands may be less dependent on the outside world for their food. It was, therefore, considered as especially desirable that the development of diversified industry be either in the actual production of food crops or, at least, in the production of agricultural products from which foods can be prepared. In normal times these crops would be available for export either in the raw or manufactured state, and, during a time of blockade or interruption of communication, they could be readily used to feed the local population.

With this end in view, various root and tuber crops were grown for their starch production, and the process of drying and preserving vegetables and fruits received careful attention from many of the station workers. F. G. Krauss, superintendent of the extension division, in company with a representative of one of the local agricultural companies, made a trip of inspection and investigation to the mainland for the purpose of furthering this work and in order to determine market possibilities, methods of manufacture, etc., covering the starch production industry. A large part of the United States was covered, investigations being made in States as widely separated as California, Massachusetts, and Florida. The experiment station and the extension division were primarily interested in this project not only for the above reasons, but because it promises to furnish additional means of livelihood for the small farmer; furthermore, after the starch has been extracted, the residual product can be made to serve as a valuable constituent of mixed feeds for live stock which now depend to a great extent upon imported feeds.

Preliminary investigations made with cassava and edible canna indicate that a profitable industry can be developed. Yields of cassava as high as 16 tons per acre, and of edible canna at the rate of 40 tons per acre, under ideal conditions as to soil fertility and moisture supply, further this possibility when one realizes that about 10 per cent of the edible canna and 25 per cent of cassava is commercially extractible starch. Cassava starch can be used commercially in sizing cotton goods, in the preparation of certain forms of adhesives, and as the source of tapioca. Because of its extraordinarily large starch grains, the edible canna has been declared superior to arrowroot starch for invalids; and it is thought that this product will, as a result, command a price sufficient to make its continued production profitable

In its further search for additional potential industries, the station devoted some time and attention to the development of methods of manufacturing various fruit and vegetable products, such as dried bananas, pickled fruits and vegetables, guava jelly, vinegar from pineapple waste, candies made up on a foundation of macadamia nuts, and the preservation of the avocado.

THE SECOND ANNUAL TERRITORIAL FAIR.

The success of the first Territorial fair, held in June, 1918, was due in large measure to enthusiasm developed by the war. While the second fair, held in June, 1919, did not receive the same stimulus, very effective work, surpassing that of the previous fair was accomplished by the county agents and other committeemen. The results of the agricultural extension work were manifested in the variety and quality of the agricultural exhibits shown. Among the exhibitors, keen competition was fostered by awarding cash prizes to those who displayed certain crops in which it was desired to arouse interest for their further development.

The second Territorial fair cooperated so splendidly with the experiment station in setting forth the desirability and possibility of diversified crop production that every available resource was temporarily devoted to bringing to a successful close those particular activities for which the station members had been made responsible by the fair commission. Each division of the station was represented by special exhibits, and most of the station staff held one or more committee assignments in connection with the various agricultural features of the fair. Acquaintances made during the food production campaign of the war period were turned by the station to its best advantage in developing enthusiasm among the various exhibitors.

The domestic science exhibits specialized on economical menus rather than on wheat and fat substitutes; the Japanese committee made a most creditable showing of numerous Japanese foods, daily changing its exhibits. The exhibit by the sugar plantations, of various industries which are receiving attention from them, was most commendable. One company exhibited the work of making cement from nonimported materials, and also demonstrated the practicability of obtaining from waste cane molasses a fuel which can be substituted for gasoline. Another plantation made an extensive exhibit covering its development of home-grown feeds for all classes of live stock. Among three exhibitors there was keen competition regarding mixed feeds which contained 50 per cent or more of home-grown products, such as pigeon-pea meal, velvet-bean meal, alfalfa meal, cane-top hay, waste molasses, cracked corn, etc.

HORTICULTURAL INVESTIGATIONS.

One of the more important features of the work of the horticultural division was that of the extension of Macadamia nut growing. About 1,000 seedlings were planted at various elevations throughout the islands. The few isolated old plantings of the Macadamia tree clearly indicate the chances of the successful production of this nut in the Hawaiian Islands.

Work with the avocado made material progress, and it is hoped that a greater interest can be aroused among growers to improve the many varieties of this fruit. Several small cooperative commercial orchards were started mainly to demonstrate the possibilities of the commercial production of the avocado. Sixteen new varieties of the Guatemalan type were received from the United States Department of Agriculture at Washington and planted for observation.

The station not only demonstrated varieties of mango best suited to conditions of the islands, but also started propaganda to further development of the superior strains. As a result numerous seedling trees throughout the islands were top-worked with improved strains, especially the Pirie, upon which the station is concentrating a good deal of attention.

The Solo papaya, which was under test, has proved to be a very promising strain. It has been brought to the fourth generation without deterioration in flavor or other desirable characteristics.

Investigations with the litchi tree were continued, and great prospects are looked for from the propagation of this exquisitely flavored fruit.

Considerable attention was also given to the coffee industry, which, owing to the prevailing low price of the coffee berry, is not in a flourishing condition.

Work with the propagation of pineapple seedlings was uninterrupted, and several thousand young seedlings were planted in commercial pineapple fields of different localities. A few of these are already beginning to bear fruit.

CHEMICAL INVESTIGATIONS.

One of the major projects of the division of chemistry throughout the year was that of drying and preserving Hawaiian vegetables and fruits. By the use of a drier, the working model of which was constructed on the station grounds, various tests were conducted with many island foods which were found adapted to preservation by drying. This drier, which is independent of weather conditions for effective results, is much more rapid in its action than the air drier, which was also kept in operation. By the use of the small vacuum drier, exact data, showing rate of loss of moisture of the various crops, is readily had. This vacuum drier has also made it possible to obtain a better product of bananas and similar fruits, since the temperature and air pressure can be regulated and determined with much greater exactness than by other methods used.

The drying and preservation of fruits and vegetables, and the production of starch from cassava, edible canna, sweet potatoes, corn, taro, etc., have opened up commercial prospects which are receiving investigation from the experiment station and from various commercial interests of the islands.

AGRICULTURAL EXTENSION WORK.

The extension division, which has kept in close touch with the various agricultural projects of the islands, endeavored at all times to develop the most practical solutions of the many problems continually arising. The headquarters of the superintendent of the extension division are located at Haiku, on the island of Maui. The installation of an efficient telephone service has made it possible for him to keep in touch with the more remote and relatively inaccessible sections of the island.

Lectures, together with voluminous correspondence, and some practical demonstrations of caponizing, home curing of pork, etc., were effective in reaching large numbers of individual farmers. The promising showing made by the pigeon pea, edible canna, and cassava, justified the appeal made by the extension division to increase the production of these crops. Every assistance was rendered home and school garden activities, and some efforts were put forth to include corn clubs, calf clubs, etc., and to further the general development of this work. A pig club was recently launched on the island of Maui, the formal organization taking place in July, 1919, with about 31 enthusiastic young people in attendance. Steps were also taken to establish a farm bureau in each of the leading agricultural sections of the islands.

Nine collaborators were associated with the division during either the whole or a part of the year, one or more being located on each of the five larger islands. During the year the superintendent of the extension division made a trip to the mainland to investigate problems of production, utilization, and marketing of such starch crops as cassava and edible canna, and to determine at first hand the latest development in extension work.

On the island of Hawaii the extension work was materially furthered by the appointment on April 1, 1919, of R. A. Goff as director of extension for that island.

At the Haiku demonstration and experiment farm the best adapted varieties of both new and staple crops were demonstrated, and seed and planting material of these superior varieties were distributed to the farmers throughout the islands.

PLANT-DISEASE INVESTIGATIONS.

The division of plant pathology continued work to develop practical methods for overcoming diseases which infest the standard food crops of the islands. The major portion of the pathologist's time was taken up with investigations of the taro rot and the banana freckle disease. The banana freckle disease, which now threatens the entire industry, is a serious malady which first came under observation in 1917. Experiments carried on in cooperation with one of the leading banana growers resulted in the systematic spraying of a 75-acre field, which is now giving very promising results. An interesting series of observations was made on root rot troubles of bananas, pineapples, and sugar cane. So far these have yielded nothing sufficiently definite to justify publication at this time.

In addition to those reported on in previous annual reports, further miscellaneous plant diseases were observed and recorded.

AGRONOMIC INVESTIGATIONS.

During the year the agronomic activities of the station were concerned primarily with the most practical means of rapidly increasing the production of food and forage crops. This was brought about by the extensive distribution of seeds, cuttings, and tubers to all who had proper facilities for growing them. As soon as it became evident that the end of the war was near, the work of the division gradually shifted from the routine work of stimulating production to the improvement of those crops the standard varieties of which were already very well established throughout the islands.

Both the Guam and the Cuban Red corn have made splendid growth, though the former has given consistently higher yields on the station plats than the latter. However, the Guam variety, because of its white color, is locally at a disadvantage, inasmuch as the market favors a yellow variety of corn. Plans were, therefore, formulated for hybridizing the Guam corn with a variety of the desired color in the hope of combining the leaf-hopper resistant and other good qualities of the Guam corn with the yellow color demanded by the local market. It is considered more practicable to try to change the color of a variety of corn rather than to try to overcome the intense local prejudice of the several races against corn of a shade other than that to which they have long been accustomed.

Experiments with the sweet potato, one of the standard food crops of the island, were carried on to develop strains superior in yield and possessing excellent market and table qualities. Great variation has already been noted in the seedlings which owe their origin in part to hybridization.

The station plats of edible canna and cassava have clearly demonstrated the value of these two root crops, and liberal distribution of these as planting materials were made. Fertilizer tests have given additional information regarding requirements of these particular crops under island conditions.

The work of the Castner substation was continued and, at the request of the Army authorities at Castner, a planting plan was prepared and submitted for the utilization of the species and varieties found to be most promising. Several days were spent by the agronomist in charge of the experiment station in locating a suitable site on the reservation for planting the more promising varieties on a much larger scale than was practicable at the Castner forage-crop substation.

POULTRY INVESTIGATIONS.

During the latter part of the fiscal year 1919 the station was fortunate in securing the temporary services of a poultry expert, L. M. Ross, who brought to completion a brief survey of poultry conditions in the islands. At present the most pressing problems with poultry are adequate housing, the provision of sanitary surroundings, and the proper methods of feeding, including properly balanced rations. It was found practicable to materially reduce the proportion of imported concentrates in the diet for island-raised poultry. Most of the poultry work of the station was conducted at the Glenwood substation on the island of Hawaii, but the present undertaking shows the need of conducting work on each of the larger islands.

GLENWOOD SUBSTATION.

The work of the Glenwood substation was directed largely to poultry and food crop production. The eggs were used for hatching purposes throughout the islands, and the surplus roosters were made available for breeding purposes. Experiments carried out in the past proved conclusively that potatoes, beans, cabbage, corn, and alfalfa can be successfully produced under Glenwood conditions; but that other standard crops are not ordinarily practicable. Among the successful minor crops were pohas, sorghum, edible canna, and pigeon peas. During the year 12 demonstration plats of alfalfa were established on the eastern side of the island of Hawaii. In many instances where very young seedlings were devastated by cutworms it became necessary to transplant the well-grown seedlings to fields. This was a laborious and expensive undertaking, but the method will have proved a practicable one if the stands maintain themselves for a number of years.

In addition to attending to his regular duties at the Glenwood substation, the superintendent did considerable extension work in the immediate vicinity of the substation. In this matter it was found practicable to cooperate with the Territorial food commission and its county agents. The district immediately surrounding the Glenwood substation was taken over by the superintendent, who acted as its county agent. The remainder of the island of Hawaii was divided between the two Territorial county agents.

Ever since the establishment of the Glenwood substation the Territory has appropriated most of the money required for its maintenance. The 1919 session of the Territorial legislature, in response to the demand for the establishment of a similar station on the opposite side of the island, transferred its financial support to the prospective Waimea substation. However, it is planned to continue the Glenwood substation without financial support from the Territory, using such Territorial equipment as will not be required at the new station. The Glenwood substation will be run largely as a demonstration station and carry on such experimental work as can be provided from the funds at hand.

CHANGES IN THE STATION STAFF.

During the year there were a number of changes in the station staff. Maxwell O. Johnson, chemist, resigned March 20, 1919, to accept a position as industrial chemist with the Pearl City Fruit Co., Pearl City, Hawaii, at a large increase in salary. He was succeeded by Wallace Macfarlane April 9, 1919. H. L. Chung, assistant in agronomy, was absent in military service from October 15, 1918, to December 10, 1919, inclusive. R. A Goff, superintendent of the Glenwood substation, was appointed extension agent for the island of Hawaii on April 1, 1919. Temporary appointments were given L. M. Ross as poultry expert April 1 to June 30, 1919; E. J. Mooklar, assistant in fruit and vegetable utilization, November 25, 1918, to February 20, 1919; and P. L. Hesketh, assistant in market garden investigations, March 1 to May 31, 1919.

REPORT OF THE HORTICULTURAL DIVISION.

By J. Edgar Higgins.

The activities of the horticultural division were considerably affected during the year by war conditions. James H. Cowan, assistant in horticulture, who left to enter military service, almost immediately upon his return to the station on July 1, 1919, accepted a position with the College of Hawaii as custodian of grounds. In the meantime no assistant in horticulture has been appointed. P. K. Lee, however, has rendered very valuable assistance in propagation work, in keeping records, in mapping permanent plantings, and in looking after much of the detail work.

While waiting further assistance an attempt was made to sustain, as far as possible, the line of work under way before the war started. Some attention was given to the Macadamia, or Queensland, nut as the basis of a possible new industry; and, on a trip to the island of Hawaii. certain phases of the coffee industry were investigated.

MACADAMIA NUT.

The Macadamia, or Queensland, nut (*Macadamia ternifolia*) (Pl. I, fig. 1), is one of the most promising of all nuts for improvement and for commercial cultivation within the Tropics or subtropics. It has received little attention, however, and in fact has been almost wholly neglected, notwithstanding the fact that it is unexcelled in richness and delicacy of flavor. This is one of the many obscure tropical products which should be brought to light, improved in some respects so as to be better adapted for commercial use, and thus be made to play an important part in feeding the world.

The tree is of upright growth, attains a height of probably 35 feet, has dark green foliage and rather dense head, and begins to bear when from 5 to 8 years of age. The nuts, which are incased in a hard shell one-eighth inch thick, are brown in color and about 1¼ inches in diameter. The kernel is perhaps three-fourths inch in diameter, nearly spherical or slightly flattened, white, and of a delicious flavor. It resembles the Brazil nut but is regarded by many as milder and more pleasing.

The trees of this species vary greatly in respect to productivity, size of nut, character of foliage, and bearing age. This is one of its splendid features, and gives rise to hope for great improvements by selection. One of the first changes brought about should be a softening of the shell, which is hard and thick. This feature probably is highly responsible for the failure of the nut to be more widely recognized and disseminated.

In a letter from Prof. Albert H. Benson, director of fruit culture for the department of agriculture of Queensland, it is stated that the thickness of shell varies considerably among the trees in their native conditions, and his observations have led to the conclusion that had the question of improving this nut been seriously taken in hand a comparatively thin shell would have eventuated ere this.

Another direction for selection and change is suggested by the fact that many of the seedlings have foliage possessing strong, spiny teeth, while others are nearly free from this objectionable feature. Although the spiny character is not so serious a matter in a nut tree of this nature as in a tree from which the fruits must be gathered by hand, it is important nevertheless to eliminate such an undesirable feature. The spines greatly interfere with the comfort and convenience of the operator when pruning, spraying, and budding.

The experiment station is endeavoring to extend the trial of the Macadamia nut tree for propagation and permanence in Hawaii. This tree was introduced into Hawaii many years ago from Queensland by Messrs. E. W. and R. A. Jordan, the latter of whom secured the seeds in their native land. Specimen trees are to be found to-day in several parts of Honolulu and throughout the islands. The trees have prospered under the conditions in which they have been tried in Honolulu, and a few which bear each year are growing on the experiment station lands on Mount Tantalus, at an elevation of about 1,000 feet.

The division of horticulture grew about 1,000 trees from seeds collected at the Tantalus gardens, and kept them in readiness for planting during the summer of 1918. The station received the hearty cooperation of the trustees of the Bishop estate, and Mr. L. Macfarlane, manager of the Captain Cook Coffee Co., regarding the matter of planting these trees on a considerable scale in Kona. On September 3 a few trees were taken to Kona and later, when arrangements were about completed, a larger shipment was sent. These trees were planted out at different elevations ranging from 600 to 2,100 feet. The soil in which they were placed varies from typical rock land, where only pockets of soil are found, to open friable loam. The trees, which were placed under the care of a large number of tenants of the estate and of the Captain Cook Coffee Co., were in some cases planted adjoining each other so as to increase the probabilities of successful cultivation. The tenants themselves displayed great enthusiasm when learning that the trees were to be planted on their lands. All the trees with only two exceptions were placed among coffee plantings at distances of approximately 30 feet, the distance varying slightly with the method that had been followed in placing the coffee trees. The two exceptions referred to were where the Captain Cook Coffee Co. made plantings of trees 25 feet apart on land especially cleared for the purpose, and also where a few trees were planted in the neighborhood of the company's mill.

About 800 seeds of this species were sown at the station greenhouses in the latter part of the year 1918, and some time during the summer of 1919 the seedlings will be in readiness for transplanting.

THE AVOCADO.

Probably the avocado will always be one of the most important fruits grown in Hawaii. No export industry exists for the reason that the fruit is occasionally infested with the Mediterranean fruit fly, with the result that it is subjected to quarantine upon arrival at the mainland ports of the United States. Demonstration, however, has proved refrigeration to be a most efficient method for destroying the eggs, larvæ, and pupæ of the fly;[3] and, in fact, entomologists claim that this method could be used under careful government control to ship the fruit without danger of carrying the pest to uninfested ports. The following conclusions of Back and Pemberton,[4] reached after exhaustive study of the insect under refrigeration, merit very special consideration in this connection:

> The data contained in this paper show that no eggs or larvæ of the Mediterranean fruit fly survived refrigeration at 40° to 45° F. for seven weeks, at 33° to 40° for three weeks, or at 32° to 33° for two weeks. They may lead to the modification of existing quarantines and encourage the refrigeration of fruit subject to fruit-fly attack. It seems reasonable to conclude that sooner or later the certification of properly refrigerated fruit will be practicable. When an association of fruit growers or a people find it financially worth while there is no reason why they can not operate a central refrigeration plant under the supervision of an official whose reputation shall be sufficient to guarantee all fruits sent out from the plant to be absolutely free from danger as carriers of the Mediterranean fruit fly.

After a large quantity of fruits of uniform grade and variety has been produced to exceed local demands, an export trade to the mainland of the United States and Canada can be developed by the adoption of the refrigeration method. Larger productions of the avocado might result, too, in a trade with New Zealand and Australia and, possibly, without the refrigeration treatment of the fruit, since the Mediterranean fruit fly was well established there many years before it was found in Hawaii. The rapidly developing countries of the Orient must not be forgotten in this connection, for as the East becomes more closely united to the West, the avocado will become as popular there as it is now becoming in the United States. A further use for the avocado will be found in manufactured products. The division of chemistry of this station prepared the fruit in several ways and reported favorably upon a test with the bottled product known as Avocado Cocktail.

There is at present, however, a good demand in the local market for all the really choice avocados—a demand which will increase not only as the population grows, but as varieties and methods of packing are standardized. With this standardization the buyer will no longer have to risk getting unsatisfactory fruit, as now too often happens when he buys, but will know exactly what to expect from his orders. Home consumption of the avocado can be easily increased three or four fold by encouraging the growth of those varieties whose fruits mature between October and May; during these months, the local markets are practically bare, except for some immature fruits which are rushed on the markets to obtain the prevailing high prices.

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[3] Hawaii Sta. Press Bul. 47 (1914).

[4] U. S. Dept. Agr., Jour. Agr. Research, 5 (1916), No. 15, p. 665.

If the avocado were to be used for the home garden only, the high food value of the fruit and its intrinsic worth would justify all the effort that the station has given it and will continue to give it. In view of the larger possibilities of this fruit, it is to be regretted that even greater attention can not be focused upon it. One of the earliest services undertaken by the station was the adaptation of methods of propagation and the actual dissemination of budded trees which made it possible to establish nursery work on a commercial basis. Several of these small nurseries are now in operation where trees of the choicer varieties can be purchased and where one can engage the services of budders to top-work older trees. The station discontinued the practice of distributing budded trees and propagation is now being confined to some new varieties which are being tested in a few small cooperative orchards. With a view to testing their adaptability to heights, a small orchard of trees was planted at an elevation of about 1,000 feet at the station's gardens on Mount Tantalus.

A number of new varieties of the Guatemalan type were received from the Office of Foreign Seed and Plant Introduction of the United States Department of Agriculture. They represent a part of the valuable collection made by Mr. Wilson Popenoe, agricultural explorer, who spent many months in carefully exploring the highlands of that country in search of the most promising types of the Guatemalan avocado. These are of especial interest to Hawaii, because, like the Guatemalan varieties now grown at the station, their fruits will probably mature in the autumn and winter months when the more common West Indian type is out of season; furthermore, they will probably assist in extending the avocado belt to higher elevations in Hawaii, since they were discovered at altitudes between 4,000 and 6,000 feet above sea level. The new varieties recently introduced into Hawaii and their identification numbers are as follows:

Varieties.	Hawaii Station number.	S. P. I. number.	Varieties.	Hawaii Station number.	S. P. I. number.
Lamat	4246	43476	Benik	4255	44626
Kanola	4247	43560	Mayapan	4256	44690
Ishkal	4248	43602	Manik	4257	45560
Kashlan	4249	43934	Cabnal	4258	44782
Pankay	4250	44785	Cantel	4259	44783
Nabal	4251	44439	Tertch	4260	44856
Nimlich	4252	44440	Ishim	1261	45562
Panchoy	4253	44625	Kanan	4262	45563
Tumin	4254	44627			

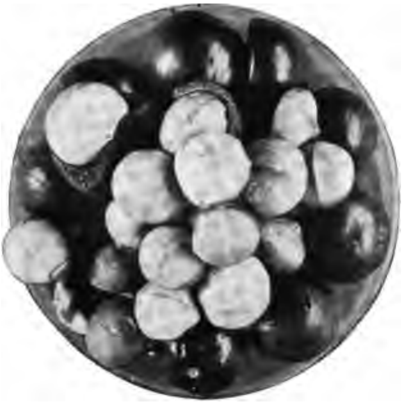


FIG. I.—MACADAMIA NUTS; UNHULLED AND HULLED NUTS AND EXTRACTED KERNELS.

Diameter of plate, 4 inches.

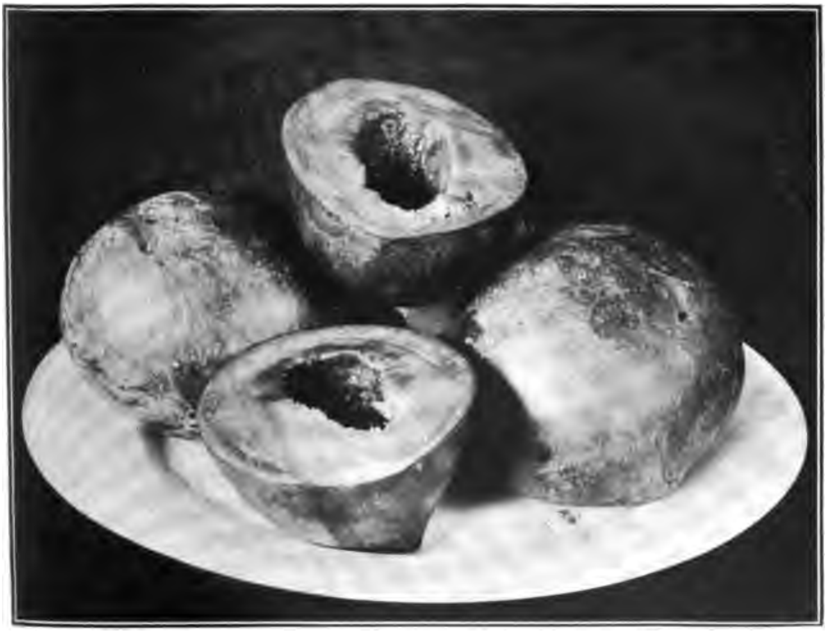
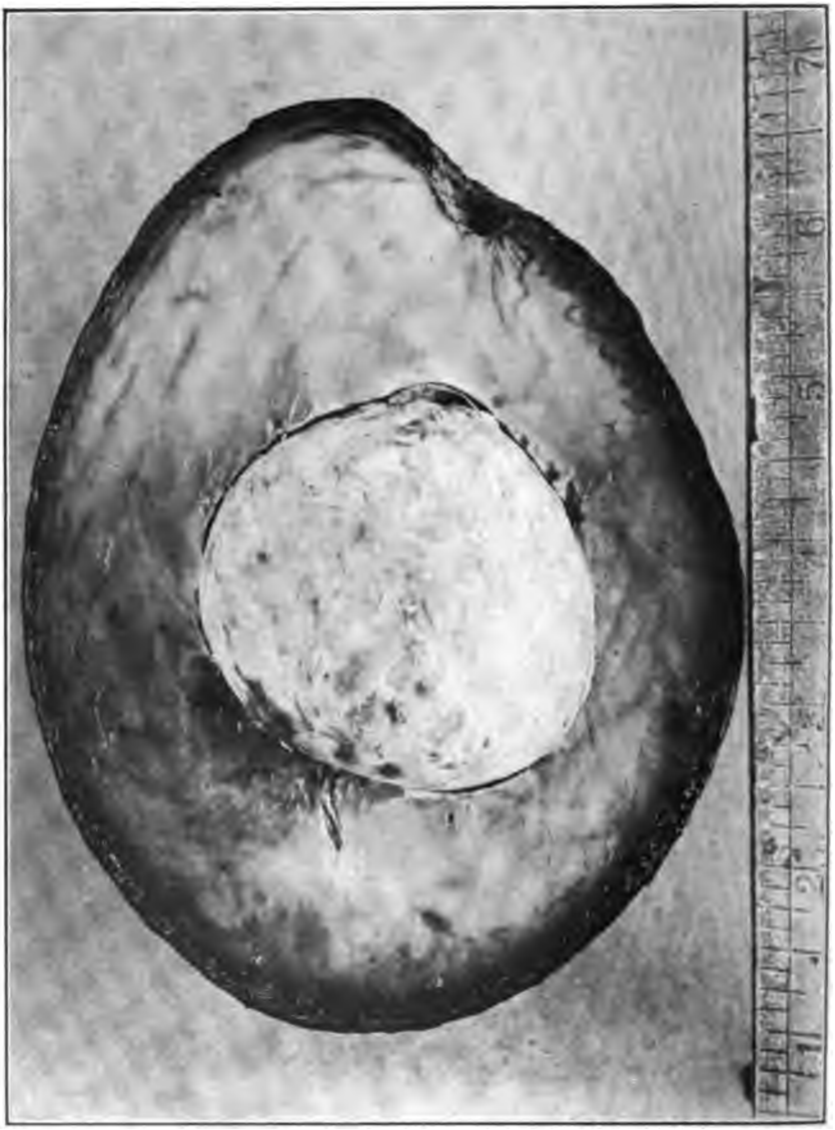


FIG. 2.—THE PIRIE MANGO, A PROMISING VARIETY FOR HAWAII.

Diameter of plate, 10 inches.

PLATE II.



THE BEARDSLEY AVOCADO.

Full descriptions of all these are being published in Washington by the Office of Foreign Seed and Plant Introduction, United States Department of Agriculture, and copies will doubtless be available for distribution.

Of each variety, one tree was placed in the small orchard on Mount Tantalus, previously referred to, and others will be planted in different places for trial as they develop.

The Beardsley avocado.—This is a new variety of the Guatemalan type of Hawaiian origin (Pl. II). It is a seedling from the McDonald, one of the two original trees grown from seed first introduced into Hawaii from Guatemala[5] by Admiral Beardsley. Other seeds of the same type are said to have been left at Hilo and probably also on Maui. This new seedling was presented on December 18, 1911, to Mr. L. C. Ables, a careful cultivator who planted it in his home gardens at 1627 Kewalo Street, Honolulu, where the tree now stands. It is known to have produced a crop within four years after planting. The season of maturing the fruit varies, as is the case with all of this type, but it is strictly a fall and winter fruit. The tree is of upright and rather dense habit, a regular and prolific bearer. The fruit is the largest and most perfect of all the Guatemalan varieties that have come under observation at the experiment station. In honor of the benefactor, who introduced the seed of the parent tree, the first of its kind in Hawaii, and who, with much care, maintained their viability this, the best of the progeny that has appeared, has been named the Beardsley.

A description of the fruit in detail by J. H. Cowan, who made the record for the station, is as follows:

> Weight 37 ounces, seed 15½ per cent, rind 13½ per cent, and edible portion 71 per cent. Shape round to pyriform. Fruit cavity, flaring, irregular, rounded, $\frac{5}{16}$ inch deep. Rind, a thick, hard shell of purple color on the surface when ripe. Pulp fine-grained with trace of fiber only at the base. Flavor, rich and nutty. Seed tight in seed cavity.

THE MANGO.

The present is an unusually good year for observations on the mango, as nearly all varieties in the station orchard are now in fruit, and other sorts have been brough in by private growers. A very important factor in mango growing is the wide variation shown by these fruits in their susceptibility to the attacks of the Mediterranean fruit fly. Fortunately, the Pirie, which gives promise of becoming the leading variety of all those introduced, and also some others of the choicer kinds are not attacked by the insect if other more attractive fruits are available.

In view of these facts, it would seem desirable to maintain with the choice varieties of mango, some other more attractive fruit, which would act as a trap in which to catch the flies. The susceptible varieties of mango would serve this purpose so far as diverting the insects is concerned; however, if these varieties are allowed to remain in the orchard, all fallen fruits must be picked up and submerged in water in order that the larvæ and pupæ of the fly may be destroyed. Unfortunately, the mango has been found not adapted to the several species of parasites introduced to destroy the Mediterranean fruit fly. According to Pemberton and Willard,[6] parasitism of fruit flies in the mango falls at times as low as 7 per cent of the total number of insects taken from the fruit during an entire month, while the average is uniformly low in the fruit. In coffee, which is a favorite fruit for the fly, there is a high percentage of fruit fly parasitism, running as high at times as 94 per cent. Were a variety of coffee to be found which ripens its fruits during the mango season, this could serve not only to protect the immediate crops, but also to greatly increase the number of parasites and reduce the fly. As above stated, there is in many localities a considerable assortment of fruit more attractive to the fly than the Pirie and some other varieties of mango. This interrelation of fruits, pest, and parasites should be kept in mind as it may frequently be found desirable to plant or graft in some fruit for the protection of the Pirie and of other choice varieties of mango.

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[5] Hawaii Sta. Bul. 25 (1911), p. 43.

The mango seed weevil (*Cryptorhynchus mangiferæ*) has become a very prevalent pest. Fortunately, it remains within the husk of the seed until some time after the fuit has ripened, and does not pollute the flesh of the mango or detract from its external appearance. Nevertheless, its presence within the seed often affects the appearance and even the flavor of a portion of the flesh surrounding the seed. In the case of the Pirie and some other good varieties, this injury is very slight unless the fruit is allowed to become overripe. The greatest injury is done to the seed, which, if allowed to remain within the husk, is usually destroyed. It is estimated that about 90 per cent of all the seeds opened at the experiment station this season were weevil infested and, therefore, unfit for propagation.

Various means are being tried to save the seeds from complete destruction. One of these consists in cutting open the husk as soon as it can be cleaned and slightly dried. When wet the husk is extremely difficult to cut, but when dried for about one day, it can be cut at the lower end at a point corresponding to the stigmatic point of the fruit; this cut may be extended up the ventral edge of the seed so as to permit the entrance of the thumb of each hand, with which the husk may be pried open and the seed removed. If the seed is found to be weevil infested, but not yet fully destroyed, the insects can be killed, the seed cleaned, and then planted. If the embryos of the seeds, many of which are polyembryonic, have been destroyed, the seed will be useless, but should one or more of these remain uninjured, the seed can be expected to grow. Seeds planted without the husk require on an average 18 days to germinate, while those planted with the husk require on an average about 40 days to germinate.[7] It should be remembered that the only way to distinguish unsound seed is to open it. If such a seed were planted without having been opened, the long period required for germination would suffice for its utter destruction by the weevil within.

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[6] Jour. Agr. Research [U. S.], 12 (1918), No. 2, p. 106; 14 (1918), No. 13, p. 607.

When a large percentage of the seeds has been found to be injured beyond the possibility of recovery, the removal of the seeds from the husks becomes a somewhat expensive though very necessary means of securing seedling plants. A less expensive, but less effective, method tried for the destruction of the insect consisted in making one rapid cut at the lower end of the seed as described above, after which the seeds were placed in a sack and submerged in water for one hour. Seeds so cut were also fumigated and, the weevil, which manifests a high degree of resistance, killed. The seed when cut open is moist within, but determination has not been made as to whether it can endure as much fumigation as the weevil will, or whether the frass or refuse created by the weevil will contribute to the decay of the injured seed.

MANGO VARIETIES.

This season has offered excellent opportunity not only for noting the local adaptability and characteristics of the mango varieties, but for establishing the synonymy of certain names. Lack of space prevents a detailed pomological description of each variety, but a few notes will serve to record the outstanding features of a number of them and to indicate those which seem best adapted to local cultivation or which are of most interest from the standpoint of breeding.

Pirie (Pl. I, fig. 2).—This variety is considered the best, at least for lowland conditions, of all the mangoes that have been introduced into Hawaii. It is of medium size, inclining to the rounded form, with a distinct beak at the stigmatic point. The surface is smooth and, when ripe, is a pale yellow beautifully marked with crimson where exposed to the sun. It is practically fiber-free, has a delightful aroma, and is as soft and juicy as a ripe peach. The seed is easily removed, so that the fruit can be served in halves and be eaten with a spoon without the slightest inconvenience. In order to remove the seed, it is only necessary to make a cut circling the fruit, about midway its length, and extending as deep as the surface of the seed. Then, by a slight twisting motion, one half of the fruit can be separated from the seed, leaving a smooth, unbroken surface within. By cutting very slightly around the seed, it may easily be removed from the remaining half of the mango. The flavor is so unusually delicious as to put this mango in a class of its own in Hawaii. The Pirie is less subject than other varieties to the black spots caused by the fungus *Colletotrichum glœosporioides*, and, while not immune to the fruit fly attacks, it either possesses a high degree of resistance, or is not a preferred variety for the fly. No injured fruits were found in this variety in the station orchards this season, though crops of several of the other varieties were rendered almost worthless.

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[7] Hawaii Sta. Bul. 12 (1906), p. 10.

Kavasji-Patel (*Cowasjee-Patel*).—This is one of the largest of the Indian mangoes introduced into Hawaii, being excelled in average weight only by the Sundersha. It inclines to the rounded form, is somewhat depressed on the ventral surface, and in color is pale green, which turns to yellow as the fruit ripens. The texture is excellent, but the flavor is somewhat inferior to that of the Pirie. The tree makes vigorous growth, but is a shy bearer.

Jamshedi.—This is a mango of large size approaching more nearly the spherical shape than most mangoes. It is of green color even when ripe, and has a good flavor and texture. The chief weakness of the variety seems to be its lack of attractiveness in color. The tree is a free bearer.

Mullgoa.—The Mullgoa is a large variety closely resembling Jamshedi, but distinguished from the latter variety by the large pale green spots which appear on the fruit.

Mulgoba.—This variety, which has proved so popular in Florida, has not attained prominence in Hawaii. The fruit is of medium size, being about the same in this respect as the Pirie. It is of good flavor and texture and is golden yellow when ripe, often splashed on the shoulder with red. The name has been considered by some as a probable synonym of Mullgoa, but it is a wholly different fruit, much more yellow and elongated.

Strawberry.—The tree, received under this name from India through the Office of Foreign Seed and Plant Introduction of the United States Department of Agriculture (S. P. I. No. 10643) seems to be identical with Pirie.

Peter's No. 1.—The variety received under this name from Trinidad, through the Office of Foreign Seed and Plant Introduction (S. P. I. No. 3706) also appears to be identical with Pirie. Doubtless the name is a more recent one than that of Pirie, which is an old established East Indian name.

Alphonse.—This variety has attained great fame in India, but, because of its lack of flavor, it has failed to become popular in Hawaii. It is of medium size and quite distinct in shape, being flattened on the ventral surface and without any prominent stigmatic point. The

Alphonse is indeed a handsome mango, being golden yellow in color and beautifully marked with crimson on the shoulder.

Hafu.—The Hafu is apparently a synonym of Alphonse.

Douglas Bennett's Alphonse.—Up to the present no consistent points of difference have been distinguished at the station between this variety and those received under the name "Hafu" and "Alphonse." However, a closer study of a large number of trees may reveal points of difference.

Ameeri.—The variety known as Ameeri is probably the most magnificently colored of all the mangoes introduced into Hawaii. It is elongated in shape and rather symmetrical, the exposed side being overlaid with a purplish hue, which changes to a gorgeous crimson on ripening, while its unexposed surface turns yellow. This mango is of good texture and fairly good flavor. The tree is vigorous and a good bearer. Because of its remarkable coloring, the Ameeri is well worth growing as an ornamental and should be of special interest to any plant breeder who desires to combine these color characters with the flavor or other desired characters of Pirie, which, though beautifully marked, has coloring less striking.

Brindabani.—The most prolific of all the mangoes that have been introduced is the Brindabani. The trees have been regular and abundant bearers, apparently devoting all their energies to the production of fruit. After they attain the bearing age they do not make rapid vegetative growth, though in healthy condition. The fruit, which is rather small and quite round, is green, the exposed surface being overlaid with dull brown or reddish tints. The flavor and texture can hardly be rated higher than fair, but it has the advantage of maturing very late, after most varieties have passed their season, and it is probably as nearly immune to the fruit-fly as any mango in Hawaii.

Totafari.—The Totafari is a handsome bright yellow mango, somewhat large, elongated, and rather symmetrical, with a prominent stigmatic point. It is of good texture, decidedly acid flavor, a reasonably good bearer, but quite susceptible to fruit-fly attacks.

Sundersha.—This is perhaps the largest mango in Hawaii. Its shape, which makes it unfavorable as a commercial mango, is very distinctly that of the letter S found also in the No. 9 mango quite familiarly known in these islands. The Sundersha is well colored and altogether a handsome mango, though not equal in flavor to some of the other varieties.

Divine.—This, the most inappropriately named of all mangoes, if judged by its performance in Hawaii, is of small size, extremely subject to the black spot disease referred to elsewhere, rather green in color, and well marked with red on the shoulder where not injured by the disease. The flesh, which possesses only a fair flavor, is highly colored, of fair texture, and surrounds a rather large seed.

Cambodiana.—Cambodiana is of an entirely different type from any of the true Indian mangoes. It was received by the Office of Foreign Seed and Plant Introduction from Saigon, Cochin China, and is regarded by some botanists as a distinct species, to which has been given the name *Mangifera cambodiana.* Evidently to this type belong the numerous seedling varieties which have long been known in Hawaii under the name Chutney mangoes, sometimes spoken of as Chinese mangoes. All of these possess a distinct aroma, the foliage having a peculiar odor and a characteristic color and shape which distinguishes this type from the Indian varieties. The fruit of the Cambodiana is of medium size, beautiful golden yellow in color, and possesses a delightful subacid flavor in the highly colored flesh, which is of good texture and fiber free.

Wootten.—The Wootten is a variety of local origin belonging evidently to the Cambodiana type or to a cross between this and some variety of the Indian type. It is of medium to large size, of golden yellow color, slightly touched with red on the exposed shoulder, of good texture and rich flavor. One of the most important features of the Wootten, which permits its being marketed in an attractive condition, is the fact that the fruit remains hard while developing a remarkably good coloring. Some otherwise excellent mangoes fail to develop a good color until they are quite ripe.

Smith.—The Smith is another variety of local seedling origin and of the Cambodiana type. It closely resembles the Wootten, but it is earlier, of smaller size, and a little more highly colored on the exposed shoulder.

Number 9.—This is a variety, or perhaps more properly a type, introduced under this name many years ago by the government of the Hawaiian Islands. Many seedlings of it have appeared, most of them rather closely resembling the original type introduced. Practically all of these incline to the letter S shape, are very juicy, fibrous, and not highly flavored. The trees are abundant bearers, make vigorous growth, and produce handsome fruit rather free from the black spot disease.

Victoria.—The Victoria is a very beautifully colored variety of the No. 9 type grown by Mr. T. G. Thrum, Thurston Avenue, Honolulu.

Hawaiian Sweet.—This is more probably a type than a variety. It was the first mango, and among the early acquisitions of foreign fruits, introduced into the Hawaiian Islands, and was probably brought here by the late Don Marin. Few of its many seedling varieties, all closely resembling each other in shape and flavor, have been considered worthy of propagation by grafting or budding.

Oahu.—Probably the only seedling of the Hawaiian Sweet mango that has proved sufficiently distinct and valuable to cause it to be given a name and to be propagated by grafting is the Oahu. This remarkably handsome mango is large, possesses a mild and sweet flavor with abundant juice and has better texture than the average of its class. Many of the fruits show a tendency to be seedless, their husk containing no seed. This character, however, is not constant.

THE TOP-GRAFTING OF MANGO TREES.

Earlier reports and bulletins of the station described methods developed for the top-working of mango trees. Hawaii, however, is not a country of orchardists, and these methods were not applied as widely as they might have been had there been available someone who could be employed to do such work. The station, therefore, undertook, about two years ago, to forward this movement by detailing to the work on part time a man who had long been in training here. As the work developed, there appeared to be a large opening for an expert propagator in this and similar lines. The station, desiring to relinquish its operations as soon as assured that the work would be continued independently, and that owners of trees could get an experienced propagator to graft them, withdrew, leaving the work to be carried on as a private business by two men. In order to disseminate choice kinds of fruit the station supplies scions of the best varieties to these men or to any others who desire them. One of the most progressive of the large sugar plantations planted several hundred seedling mangoes along its avenue, and is having them grafted with choice East Indian varieties.

The very excellent crop of the Pirie variety this season made it possible to bring this fruit to the attention of the people by exhibitions which were held in prominent places in the city; and, at a luncheon given by the Honolulu Ad Club, its excellent qualities were demonstrated. This club has appointed a committee to aid in forwarding the movement for better mangoes in Hawaii, by means of substituting the Pirie and other choice varieties for the many inferior seedlings. As soon as the merits of these more recently introduced varieties become widely recognized, there will be a general movement to produce the best; the Territory will then be supplied, as it ought to be, with mangoes of real merit, and, should the quarantine regulations undergo changes suggested by Back and Pemberton in their above-mentioned discussion of the avocado, the exporting of mangoes may very easily become an important industry.

The station this season is conducting experiments in canning and drying the Pirie, and should either of these methods prove successful in producing a preserve which approaches the excellence of the fresh fruit, an industry of very large possibilities would undoubtedly be developed.

THE SOLO PAPAYA.

This variety of papaya (Pl. III, fig. 1) which has been under cultivation through four generations, has transmitted its characteristic flavor and texture, and to a reasonable degree its shape, in all of the plants of its kind that have come under observation. To this variety has been given the name "Solo." It is quite small, in some instances the fruits permitting of only one serving; in others, the fruit is large enough for two servings. Most plants of the variety are hermaphrodite or bisexual, but a staminate tree is found occasionally. Although the fruits are small, they are crowded into the axil of nearly every leaf and are so numerous that the yield is reasonably heavy, yet not equalling in weight that of some of the large kinds. The fruit is pyriform, somewhat irregular, colors well and uniformly before softening, and is free from the diseased spots which attack the surface and penetrate the pulp of many of the large forms, The flesh is of medium thickness, of bright yellow color, smooth. tender almost to melting, and of delicious flavor even near the stem end where many papayas lack flavor. The seeds, which are abundant, permit of ready and rapid means of propagation, and, because of the loose placenta or inner lining of the fruit to which the seeds are attached, they are very easily removed when preparing the fruit for serving. From the standpoint of the home gardener, the Solo is considered one of the best of the papayas that have been grown at the experiment station, for, although small, its qualities of texture and flavor give it first rank. The Solo can be used as an individual fruit.

This variety is being quite widely disseminated throughout the Territory by the distribution of seeds and seedling plants. Several other kinds of papayas, under selection for several years, were also sent out in rather large quantities. The purpose of this distribution was to establish the best varieties in as many places in Hawaii as feasible, and also in other parts of the Tropics. Nearly every mail brings requests for seeds of the Hawaii Station selections. In general, it is possible to assign to each applicant only a limited quantity for trial and further propagation, but on one or two occasions where a hurricane had destroyed much of the vegetation, as was the case in the island of Guam, several pounds of seed were sent. In one or two cases, cooperative plantings were made where it was possible to keep them under close observation.

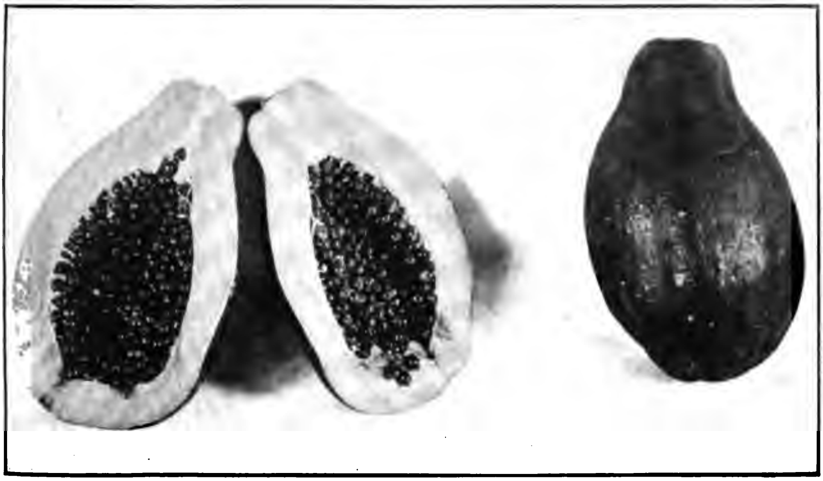

FIG. 1.—THE SOLO PAPAYA. LENGTH OF FRUIT 6 INCHES.

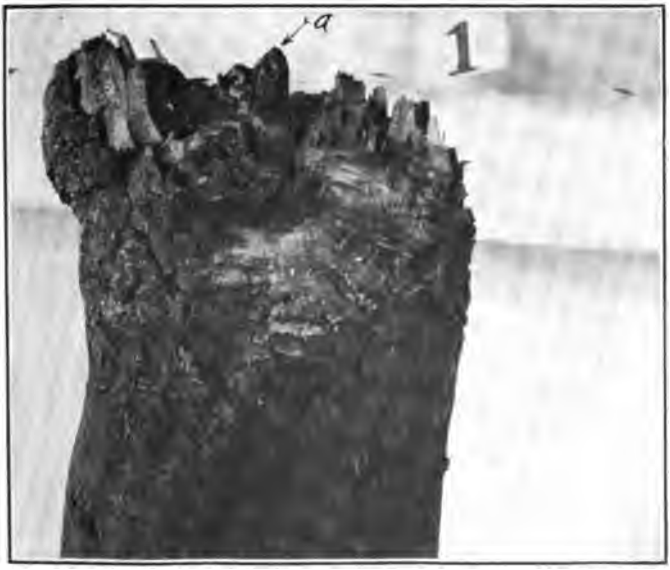

FIG. 2.—TRUNK OF LITCHI TREE BROKEN OFF JUST BENEATH SURFACE OF SOIL, SHOWING (*a*) DEAD STUB OF LAYERED BRANCH.

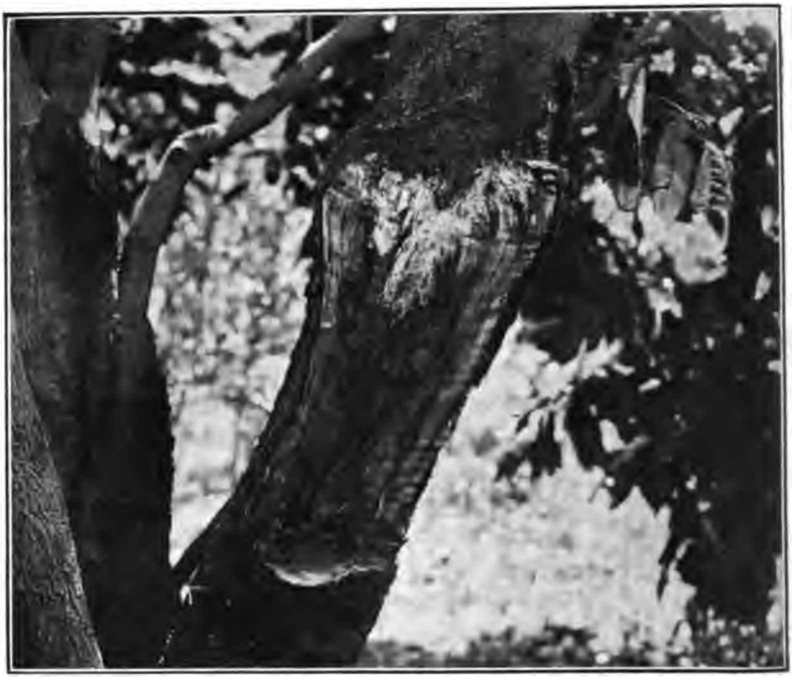

FIG. 1.—LONGAN TREE SHOWING INHERENT WEAKNESS IN STRUCTURE DUE TO MANNER OF ATTACHMENT OF BRANCHES.

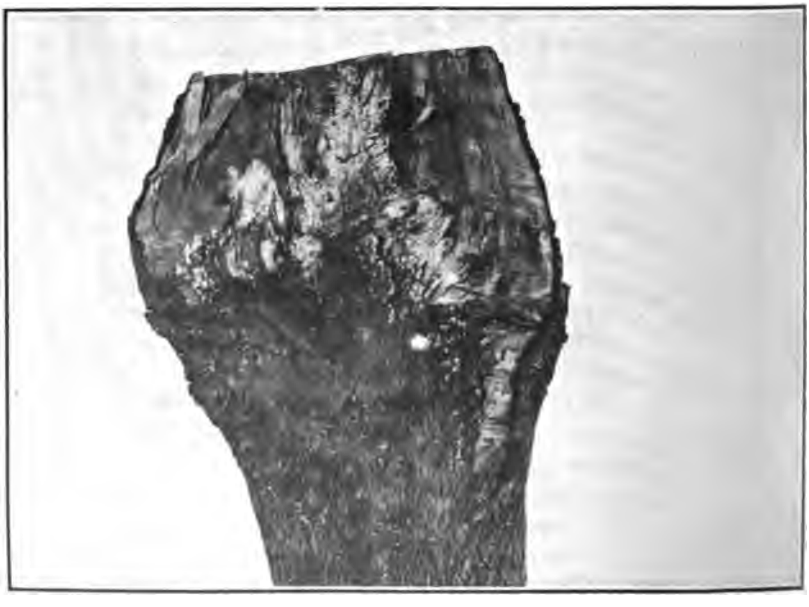

FIG. 2.—BRANCH BROKEN FROM TREE FIGURED ABOVE, SHOWING MEAGER ATTACHMENT.

THE LITCHI.

It has not been possible to extend the investigations of the litchi as rapidly as was desired. The propagation of the varieties in the station collection is being continued. In the latter part of May, 1917, G. Weidman Groff, professor of agriculture in the Canton Christian College, Canton, China, arrived at Honolulu en route to Washington, D. C., bringing with him certain varieties of litchi plants intended for the Office of Foreign Seed and Plant Introduction of the United States Department of Agriculture. These varieties did not endure the journey well, and it was feared that a further trip of 5,000 miles would result in their total loss. The plants were, therefore, left in the care of this station where it was possible to restore to a growing condition the following varieties: Waai Chi, Kwei Mei, San Hing Heung Lai, Saam Uet Hung, Haak Ip, and T'in Naam. It was possible to cooperate with the Office of Foreign Seed and Plant Introduction also in aiding the further trial of the litchi in Florida by shipping to Washington in June, 1918, 25 pounds of fruit to be used for further propagating this species.

It is well known that the customary method of propagating the best varieties of litchi is that known as Chinese, or air-layering. This consists essentially in the removal of a ring of bark from a branch, and surrounding the wound with soil or moss which is kept constantly moist until root formation takes place from the upper or outer side of the wound. It is, however, questionable whether such a root system is ever as satisfactory as that produced from the growth of a seed. Plate III, figure 2, shows the stump of a litchi tree broken off just beneath the soil by the storm which occurred early in December, 1918. In the center of the wound may be seen, at the point *a*, the remains of the old branch which was layered to produce the new tree. This small piece of dead wood was simply the remains of the old branch from which the bark had been removed, and was of no service to the new tree after it extended downward beyond the root system. It will be seen that the root system was apparently very meager, although this tree had reached a height of 10 or 15 feet. Further observation disclosed the fact that the grain of wood at the point of junction between the roots and the stem was hardly favorable to strength of structure. It is often noticed when taking young litchi layers from a parent tree that only one or two good roots have formed. It is problematical whether further roots grow except those which serve as an extension and amplification for the roots present when the layer is taken from the tree. Whether or not an exhaustive study has been made of the root systems of air-layered litchi trees is unknown to the writer. It was pointed out in an earlier publication[8] that the system of air-layering is likely to be superseded by the budding or grafting of the litchi on seedling stocks of its own, or of some closely allied species. Present observations on the root systems of an air-layered tree, suggest a further possible reason for developing other methods of propagation than that commonly practiced in the land of the litchi. In Bulletin 44, above referred to, reference was made to the temporary success of grafting the litchi on the longan. For more than a year these grafts remained in a flourishing condition, but later a peculiar condition developed which resulted in the failure of all the trees. This failure was attributed to incapability on the part of the litchi growth to sustain the longan stock upon which it was placed. Shoots were sent out by the longan, but these were persistently removed to encourage the growth of the litchi. In some instances large swellings were thrown out by the litchi branches, some distance above the point of union, suggesting the possible backing up or concentration of material at these points. Prof. Wilbur MacNeil, of the Oahu College in Honolulu, grafted scions of the litchi from this station into one or two branches in the top of a longan tree in his garden. This work was done at the time when the station trees gave promise of success. These branches continue to grow in the top of the tree surrounded by longan branches, a fact which bears out the theory that incompatibility between the stock and the scion is due to inability of the scion to nourish the stock.

The structure of the longan tree.—Attention is herein directed to certain observations on the structure of the longan tree. Although this species does not at present give great promise as a stock for the litchi, it is well worthy of cultivation for its own fruits. Plate IV, figures 1 and 2, shows the manner of attachment of the branches of the longan, and also a large wound caused by the breaking off of a branch under the stress of wind. A careful study of the attachment of the two remaining branches shown, and of the wound, will prove inherent weakness in the manner of attachment of the branches. It will also be seen from the wounded surface of the removed branch, as well as from the wound on the remaining branch, that there was practically no attachment above the point where the grain in the branch was parallel with the grain in the remaining limb. These observations point to the importance, when pruning, of selecting branches of the best possible attachment for the formation of the main framework of the tree and of the early elimination of branches that are very poorly attached.

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[8] Hawaii Sta. Bul. 44 (1917), pp. 10, 11.

COFFEE.

In September, 1918, the horticulturist made a trip to the island of Hawaii for the purpose of investigating certain phases of the coffee industry of that island, especially regarding its status, its needs, both from an agricultural and from an economic point of view, and the availability of some of the by-products of coffee culture as possible sources of caffein.

As an introduction to notes relating to coffee, there is herewith submitted a brief review of the system now commonly used in coffee growing in Hawaii, and the process of preparing it for market, which perhaps may make more clear certain statements relating to by-products and also to the present conditions of the industry. Coffee is grown in Hawaii chiefly on the tenant-farm system. In the Hamakua district there is one large plantation which is cultivated by the owners with employed labor. This plan may be carried out to a limited degree by some planters in Kona, but for the most part the lands, in lots varying from 5 to 25 acres, are leased to small growers. In many instances, these lands are leased from the owners by coffee companies, these in turn subleasing them to others. A large part of the crop, while still in the cherry, is sold to the mills. A considerable portion also is pulped and dried by individual owners on small drying floors and later sold in the form of parchment coffee. The pulping is sometimes done by a small machine in a given locality for a small charge, when the coffee is returned to the owner for drying. The small growers do not attempt to remove the parchment, because the machinery required for this process is somewhat expensive, and some large growers prefer to hire this service rather than install the machinery for the work.

In Hawaii the process of preparing coffee for market is the one commonly employed for washed coffee. After it is picked, the coffee cherry is taken to the pulpers as promptly as possible, though it does sometimes remain in the bags for two days or more. It is then passed through the pulping machinery which separates the seed from pulp. The small machines consist of a roller having a rough surface. To secure a rough surface, the roller is sometimes covered with a sheet of brass through which holes have been made from the under surface. The heavier machine used in the mills consists of series of three or four rollers, the first of which crush and separate the larger fruits, and the later ones the smaller. The pulp is carried away by hand or by automatic carriers to a convenient place where it is allowed to ferment. After fermentation takes place, the pulp is used for fertilizer, and in the larger mills it is used in part for fuel. The coffee seed as it is separated from the pulp is covered with a sweet gelatinous substance which must be removed before the coffee can be properly washed and dried. To facilitate its removal, the wet coffee passes to fermentation tanks where it is allowed to remain for 24 hours or more, after which it can be washed. In the larger mills there are revolving washing machines which churn the coffee with water and remove the gelatinous cover. The cleansed seed is then taken by automatic carriers, or, in the case of a small grower, by hand, to the drying floors where it is spread out for the first drying. Every precaution is taken to prevent rain from falling upon the beans. From time to time, as necessary, the seed is turned and stirred so as to prevent musting, and to hasten drying. At the mills, after the free water has been eliminated, by the first drying process, the coffee is taken by automatic carriers into the mill for more complete artificial drying, various devices being used for this purpose. When sufficiently dried, either by natural or artificial methods, it is ready for sale as parchment coffee. The outer husk or parchment-like cover is then removed, and the thin, soft covering, known as the silver skin, or waste material is separated from the cleansed coffee bean. The best machinery also grades the beans according to size, after which damaged beans are removed by hand from the best grains. On a large table, which is divided into compartments or bins, the beans are usually spread out sufficiently to make it possible to quickly find and remove the undesirable ones. In one mill at least, where machinery used for this process is under the control of the operator, a movable-belt table passes toward him, carrying a small quantity of coffee beans from which damaged specimens are picked out by hand. It is chiefly in this form that most Hawaiian coffee is marketed for export trade, though roasting, grinding, and packing are used to a limited degree.

Present status of the coffee industry.—The coffee industry in Hawaii, in addition to struggling for many years against competition with imported coffees grown on cheap land by low-priced labor, was, as a direct outcome of the war, completely cut off from many of the large markets of the world; prices dropped so low that coffee growers received less than in prewar times, and the cost of production was necessarily increased by the rise in the price of labor. Still more serious was the rise in the price of commodities which coffee growers need for their maintenance. Many of the growers are of oriental descent, and rice is their staple food. As one of the growers stated the condition: "Before the war three bags of coffee cherry would buy one bag of Japanese rice. Now it requires eight bags of cherry to buy one bag of rice." Rice advanced from $5 to $6 per bag to about $13, and coffee cherry fell from over $2 per bag to $1.65. While the American farmer on the mainland paid high prices for certain commodities, he received in return large prices for his agricultural products. The tide for the Hawaii coffee growers on the other hand was against him both in the price of production and distribution.

At the time of the present writing, June, 1919, the price of coffee has advanced to a price which breaks all recent records. This is, no doubt, due in great part to conditions brought about by cessation of war and the reopening of European markets, and perhaps also to frosts which are reported to have occurred in some of the coffee producing areas of Brazil. This rise in price probably came too late in the season to prove of immediate benefit to the producers, the sale of their crop being generally arranged in advance of the harvest season, or very soon thereafter because of shortage of funds. Should these high prices prevail through another harvesting period, coffee growers may expect to profit by the advance. Since, however, these prices can not be expected when normal conditions are restored, everything possible in the meantime should be done to assist this struggling industry of Hawaii.

Agricultural needs of the coffee industry.—Some years ago the green scale, *Coccus viridis*, menaced the industry; this pest is now however controlled by natural enemies. From an agricultural point of view there is no reason why the coffee business might not be greatly extended and it doubtless would expand rapidly were economic conditions to change in its favor. There is need, however, for experimental work along many lines. In Kona, one of the leading districts, no shade has been used on most of the plantings. Many of the trees have suffered no doubt for want of shade, but only after careful trial can it be determined where and under what conditions shade trees are needed, and what trees are best adapted to this purpose. The experiment station used a few trees of the *Inga laurina*, which were planted for trial by the Captain Cook Coffee Co., while the silver oak (*Grevillea robusta*), kukui (*Aleurites moluccana*), and others were tried to some extent by others. Very careful investigation, however, should be given the subject of shading so that definite data will be available.

Pruning of coffee trees in Kona, Hawaii.—In Kona no very definite method of pruning coffee trees is practiced by most growers. Pruning experiments are needed to determine their relation to shade, to varying distances required for planting, to ascertain individual differences in trees, and also to discover their relation to prolonging the life and increasing the productivity of the trees. The trees were planted at distances varying from 4 or 5 to 10 feet apart; the tendency appears to have been that of too close planting. Another matter needing immediate attention is that relating to proper distances in planting. Many of the older trees, where planted very close, have grown to great height for light and air and practically their only bearing surface is on top. Only a small bearing surface has been the result, therefore, despite the fact that a large number of trees were planted to the acre. Some experiments might be well worth while in order to determine whether it would be practicable to restore these old trees to health and productivity by some renewal system. Fertilizer experiments are also needed in order to determine their most effective and economical use.

Another promising field for experiment would be to select trees of unusual vigor and productivity and propagate them by asexual methods so as to develop greater uniformity. These methods of propagation might also prove of value in top-working old plantings to a superior strain. At present there are only two recognized commercially grown varieties in Hawaii, one known as the Hawaiian coffee, the progeny probably of a very early introduction, and the other the Guatemalan, which was introduced 20 or 30 years ago during a time when coffee growing was prospering.

Budding and grafting experiments.—Certain simple trials in budding and grafting, along the lines just indicated, were undertaken by the writer during a brief stay in Kona. Mr. L. Macfarlane, manager of the Captain Cook Coffee Co., called attention to a few trees of the Maragogipe variety of coffee grown for trial from seeds introduced by him some years ago. This variety of coffee was discovered in Brazil about 1870. It produces a large berry and large bean, commands fancy prices and is well worth very careful trial in Hawaii. Mr. Macfarlane secured the variety in Mexico, where it is grown to some extent. Buds from this variety were inserted on the main stem of some 2-year-old trees, and also on a few suckers in the upright-growing branches of older trees. Scions were also taken from this variety and were inserted as cleft grafts and also as bark grafts on the main stem of 2-year-old trees and also on the large upright growths of older trees. Coffee trees make two distinct forms of growth, the upright and the lateral. It has been found that coffee buds taken from the lateral growths continue to produce lateral growth in the new trees on which they are placed, and it is only by the use of the dormant buds subtending laterals on upright growths that it is possible to secure a normal upright budded or grafted tree. A letter from Mr. Macfarlane concerning the outcome of this work, which was performed shortly before leaving Kona, indicates that the budding was quite successful on the younger trees but on the older stocks grafting succeeded better than budding. However, the work was on too small a scale to justify any general conclusions as to the best methods of propagation, and should be regarded as preliminary to further experiments which may be carried on.

Coffee by-products.—In a letter from the Chief of Insular Stations, States Relations Service, United States Department of Agriculture, it was requested that the practicability of recovering the caffein in coffee pulp, prunings, etc., be investigated in Hawaii. The following extract of a letter from Dr. Frederick B. Power, pharmaceutical research chemist in charge of Phytochemical Laboratory of the Bureau of Chemistry, United States Department of Agriculture, presents the problem:

> This laboratory has for some time been interested in the question of the utilization of sources of caffein other than those heretofore employed. A preliminary examination of coffee leaves and coffee pulp obtained from Porto Rico have shown that they both contain appreciable amounts of caffein. It would be of interest to us to know to what extent such material would be available and at what period of the year the leaves and pulp could be obtained.

An investigation was made in Kona and in east Hawaii to determine the amount of such materials as might be used in this way, and also their present uses and the possibility of their availability for the proposed purposes. These two districts comprise nearly all the coffee-growing parts of the Territory, the remaining scattered portions producing probably less than 5 per cent of the whole crop.

Kona and east Hawaii produce approximately 50,000 bags of clean coffee per year, more than 80 per cent coming from Kona. About 6 bags of coffee cherry, or 600 pounds, are required to yield one bag, or 100 pounds, of cleaned and dried coffee. This means that of the 30,000,000 pounds of coffee cherry produced, 5,000,000 pounds are marketable coffee. It requires 120 pounds of coffee in the parchment to make 100 pounds of clean coffee ready for market, the loss of 20 pounds representing the horn skin, or parchment, the silver skin, and an occasional bad bean. For every 500 pounds of marketable clean coffee there have been eliminated 100 pounds of this waste material. There are, therefore, approximately 1,000,000 pounds of this dried material produced annually.

The proportion of weight of pulp to the entire weight of cherry has not yet been carefully worked out at the coffee mills, since there was no special reason for determining it, and further because water is usually added in the pulping process. From two 10-pound samples of coffee cherry gathered from the station plantings on Mount Tantalus it was estimated that the pulp constituted approximately 47 per cent, including the water lost in the pulping process. The wet beans represented 53 per cent of the whole and the pulp contained 80 per cent water. The proportions of pulp and of moisture in the pulp would vary with different climatic conditions, and with the different varieties of coffee, but these figures are only approximate.

From the 30,000,000 pounds of cherry there would be 14,100,000 pounds of pulp. Of this, 20 per cent, or 2,820,000 pounds, represents the weight of dry matter.

To summarize, it may be said that at present the by-products from the coffee cherry in Hawaii are about as follows:

	Pounds.
Parchment and silver skin	1,000,000
Pulp:	
Containing 80 per cent moisture	14,100,000
Moisture free	2,820,000

This material, if desired, could be secured chiefly in the late summer and the autumn when the crop is being gathered and milled. It is difficult to estimate the weight of prunings that might be available for the purpose of caffein extraction. Many of the plantations or coffee farms do very little pruning; a few others prune quite systematically. At the present time there may be 2,000,000 pounds of prunings, but this amount would increase manyfold were the material to be sold at a price high enough to pay for the cost of the labor. While the advantages of judicious pruning are recognized in Hawaii, the prevailing precarious conditions of the coffee business has caused growers to hesitate to undertake the expense of pruning, particularly now that labor is so high and difficult to secure. Those widely scattered prunings now available are practically waste and they can be secured for little more than than the cost of gathering.

The dry products, silver skin and the parchment, generally used for fuel, are considered waste products at some of the mills. These could probably be available for the extraction of caffein if this operation proved profitable. The silver skin and parchment are centered at some of the half dozen mills in Hawaii.

The pulp is used in part as fuel, but the most of it is returned to the soil to act as fertilizer. Its value as fertilizer probably would be a criterion of the price required to secure the material for some other use. In November, 1911, an analysis of coffee pulp as a fertilizer was made by Mr. S. S. Peck, at that time chemist of the experiment station of the Hawaiian Sugar Planters' Association. Through the courtesy of Mr. P. S. Burgess, chemist of that station, a copy of the analysis made is submitted herewith.

Analysis of coffee pulp.

	Moisture free.	Original material.		Moisture free.	Original material.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Water		62.00	Potash	3.91	1.49
Phosphoric acid	0.54	.21	Total ash	9.97	3.79
Nitrogen	2.18	.83			

In addition to the actual content of its fertilizing constituents, coffee pulp is thought to be quite valuable as an amendment to the soil. In a tropical country where humus is rapidly depleted from a soil that is kept constantly under cultivation it is important that the value of the pulp as a substitute be considered. Coffee pulp is much more widely scattered than parchment and silver skin because many small growers do their own pulping with hand pulpers or by those operated by gasoline engines. A considerable portion of the pulping work is, however, centered at two or three mills.

VANILLA.

Some attention was given to the present status of vanilla cultivation in Kona, where two or three attempts were made to establish an industry. Capt. R. V. Woods is successfully producing vanilla beans and an extract of fine quality. In another part of Kona a large number of healthy vines were found climbing onto trees in a tropical jungle where an extensive vanilla plantation had been abandoned. Were a number of cuttings from these plants disseminated for trial among coffee growers and others they undoubtedly would make thrifty growth in some parts of the Territory even better adapted to the needs of vanilla than Kona. The plant requires humidity and heat, and Kona is inclined to be cool in most of the humid parts. The vicinity of Hilo or the Puna districts of the island of Maui probably would prove favorable spots for future tests.

PINEAPPLES.

The propagation and planting of seedling pineapples was furthered and several thousand of the young seedlings were placed in the commercial pineapple fields of different localities. A few of the first plantings made under these conditions are now beginning to fruit. Interest in the growing of pineapple seedlings developed to a remarkable degree and the work was entered into by the Hawaiian Pineapple Packers' Association on a scale exceeding the financial means of this station. It is gratifying to see this promising work being developed in such a vigorous manner.

THE ALGAROBA TREE AND RELATED SPECIES.

A number of species of Prosopis, introduced as seeds from several parts of the American tropics, were planted on the station grounds, where they are under close observation. Some of these are about to begin to fruit, and the character of their fruit and foliage will soon be apparent. Several thousand seedlings were grown from the seeds of selected trees in cooperation with plantings made by those who are interested in the algaroba-bean industry as a source of ground feed for stock. Some of these were distributed on the other islands of the group, and near Honolulu, where a large planting was made, plans for future observations are under way.

NEW OR RARE PLANTS.

Through the kindness of Mr. John Scott, of Hilo, the station was presented with a number of fruits from the only bearing tree in Hawaii of the ivory nut palm (*Cœlococcus carolinensis*). These nuts, which are illustrated in Plate V, figure 1, are the source of a material which is known as vegetable ivory, and which is frequently used in the manufacture of buttons and similar products. Although this tree will probably be of little, if any, economic importance to Hawaii, it is of considerable interest as an ornamental and as a specimen of an economic plant. Some of these seeds are sprouting in the station greenhouse despite the fact they are said to be difficult of germination.

The Mandarin vine (*Holmskioldia sanguinea*), which was collected by the horticulturist in Porto Rico in 1914, is proving to be a valuable acquisition to the ornamental plants of Hawaii. While it is naturally a climber, it can be grown without support. From a distance its handsome, brick-red colored bracts suggest the brick red variety of the bougainvillæa.

Among the other new or recently introduced plants are a superior variety of Chinese jujube (*Zizyphus jujuba*); Paraguay tea (*Ilex paraguayensis*); a timber bamboo (*Phyllostachys bambusoides*); several varieties of pineapple; several species of Cinchona, which furnish the cinchona or Peruvian bark, the source of quinine; several species of citrus relatives; snake gourd or Guada bean (*Trichosanthes anguina*); and several varieties of mulberry.

HORTICULTURAL EXTENSION WORK.

A large part of the time of the horticulturist is at present required in extension-work activities. During the past two years some of these were carried on in connection with the annual Territorial fairs, one of the main objects of which was to foster and further interest in local production so as to increase the food supply of the island. The exhibit of the horticultural division, which occupied one side of the station booth, showed some of the more recently introduced plants, the methods pursued in propagating pineapples from seed, a number of tropical fruits which were preserved in exhibition jars, the method pursued in growing strawberries in a barrel on small city lots, Macadamia nuts shelled and unshelled, and served as a confection after having been prepared by dipping in chocolate or in fondant; and sundry other features illustrating the work of the division.

During the few months preceding the fair, the attention of the horticulturist was directed chiefly to activities of the several committees on fruits, vegetables, field crops, and flowers. This year, in connection with the prize contest conducted by the Honolulu Star-Bulletin with the cooperation of the department of public instruction, he again acted as one of the judges of school and home gardens of the children on the island of Oahu. It is gratifying to be able to record that since this work was begun there has been a marked improvement in the gardens both at the schools and at the homes. Some of the children walked miles in order that they might take advantage of the plats available for their gardens; in some cases, not only tools and manure were carried long distances, but daily trips were made so that the plats might receive watering and other cultural attention, and many young people carried the produce on their backs to a suitable marketing place.

The writer, while on a trip to the island of Hawaii, elsewhere referred to, made observations on the progress of the island's food production, and gave demonstration lessons in budding and grafting to some of the collaborators of the station and to others who would impart the knowledge. An increased interest in food production work was aroused among plantation owners, and laborers, homesteaders, and the planters of small holdings, and suitable opportunities presented themselves in many parts of the island for the further distribution of food crops, especially the selected varieties of sweet potatoes, cassava, edible canna, and papaya.

On the Parker ranch, at Waikii, splendid work in the production of about 3,500 acres of first-class corn was accomplished, and Mr. A. W. Carter, the manager, estimates the weight of corn produced equal to the entire importation of wheat flour in Hawaii during the last year.

It was noted that all along the Hamakua coast and in Kona plantings of upland taro were being made as rapidly as it was possible to secure this stock for propagation; this bespoke interest and enthusiasm in a material which had not only advanced in price, but was hard to secure.

One of the most interesting observations in Kona was that of the successful growing of squashes, pumpkins, watermelons, and even muskmelons. For the last 20 years it has been impossible to grow muskmelons or cantaloups in the Territory because of the devastations which resulted from attacks of the melon fly. The parasites introduced to control this insect have proved a success in this respect. Entomologists attribute the fact to prevailing excellent conditions which tend to aid its work. In almost every part of the district there is found a cucurbitaceous vine known as the wild cucumber (*Momordica charantia*), the fruit of which acts as a favorite host for the melon fly. Fortunately, it is a fruit into which the parasite can penetrate and find the larvæ of the fly. This wild plant functions as a trap into which the melon fly lays its eggs, which are destroyed in a later stage of their development.

The Kona orange is again coming into its own after having suffered from scale-insect and fruit-fly attacks. Citrus trees thrive very well in Kona. In fact, it is doubtful whether any other part of this Territory gives greater promise for the successful cultivation of the finer varieties of oranges, grapefruits, lemons, and limes. It would be worth while to increase the planting of all of these kinds of citrus in Kona.

The station is confining the distribution of seeds and plants, as far as possible, to a few sorts which it has produced, or to those considered most important for general growth, and which can not be readily obtained elsewhere. Many thousands of seedlings of the station variety of tomato bred as a resistant to the melon fly, and an equally large number of papayas of the station variety were distributed. The practice of the station has been to disseminate seeds of these new varieties rather than the plants, except where only a few plants can be grown, as on small city lots.

The burden of extension-service work was further enhanced by a daily increasing number of telephone and letter inquiries for information covering a wide field of horticultural and related subjects.

REPORT OF THE CHEMICAL DIVISION.

By MAXWELL O. JOHNSON and KIM A. CHING.

As food shortage conditions prevailed during the greater part of the fiscal year, the chief work of the chemical division consisted of studies of means and methods for the preservation and utilization of food. Experiments were made in drying and canning local fruits and vegetables. Investigations covering the manufacture of starch from a number of different local sources were made, and the manufacture of vinegars received much attention. Vinegar, which when tested surpassed the required local standard (4 per cent acetic acid), was successfully made from pineapple juice. A number of analyses were made of home-grown feeding stuffs and of soils, and an extensive fertilizer experiment with bananas was started. The investigations on the biochemical effect of manganese were continued.

DRYING HAWAIIAN FOOD PRODUCTS.

During the past fiscal year experimental work in drying was greatly facilitated by the completion of a large tower drier and the installation of a small vacuum drying system. The tower drier holds trays 3 feet wide by 4 feet long. A blower, driven by a small gasoline engine, forces air around steam coils and up through the trays in the tower. Regulation of temperature can be had by varying the number of steam coils used, and by altering the steam pressure. The velocity of the air can be controlled by changing the speed of the blower. Experiments were run on a semicommercial scale with this drier and satisfactory results were obtained. In the following table is shown the percentage of dried fruit and vegetables obtained from the tower drying system:

Yield of dried fruit and vegetables produced in tower drier.

Materials.	Weight of original.	Weight of peeling.	Weight of peeled root or fruit.	Weight of dried product.	Dried material from original.	Dried material from peeled root or fruit.	Moisture loss.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Per cent.*	*Per cent.*	*Per cent.*
Sweet potato	200	39¾	160¼	53	27.0	33	67.0
String beans	10	....	....	1½	14.4	....	85.6
Carrot	8¼	....	....	1¼	15.1	....	84.9
Turnips	5¾	....	....	⅜	7.6	....	92.4
Cabbage	8	....	....	⅞	11.2	....	88.2
Cucumber	9⅛	....	....	7/16	4.8	....	95.2
Pineapple	38	10	28	5⅛	13.4	18.3	81.7
Papaya	8⅝	1⅝	7	1 5/16	11.5	13.4	86.6
Mango	7½	[a] 4⅞	2⅝	1¾	23.3	66.6	33.4

[a] Peeling weight, 2⅛ pounds; seed weight, 2¾ pounds.

PRESERVING HAWAIIAN FOOD PRODUCTS.

A number of unsuccessful attempts were made to preserve the avocado fruit, as when heated, to sterilization temperature, the fruit developed a very bitter disagreeable flavor. The best method employed so far was that of cutting the peeled halves into small cubes, handling them meanwhile as aseptically as possible. After this the cubes were placed in a sterilized jar, which was filled with an ordinary commercial tomato cocktail sauce heated to the boiling point. Avocado preserved in this manner has kept in good condition for a year.

Papayas may be preserved in a manner similar to the avocado, or the two fruits can be combined.

Experiments were also made in the utilization of pineapple juice, which is a waste product of the canning industry. By mixing and boiling down equal parts of clarified pineapple juice and guava extract, a very good jelly, which was considered greatly superior to ordinary guava jelly, was obtained. Pectin precipitated from guava extract by alcohol and added to pineapple juice made a good jelly after being boiled down. Experiments were made in concentrating pineapple juice by freezing. This method, which gave good results, consisted in freezing the juice in an ice-cream freezer and separating the concentrated juice by centrifugal action.

MANUFACTURE OF STARCHES.

An attempt was made to manufacture starch from pineapple stumps. Extraction of the starch was made by grating the stumps, which contained many hard fibers. Because of a slowness in settlement, due to the fineness of the starch grains, some trouble was experienced in separating them from darker woody particles. About 2.5 per cent of starch, based on the weight of the stump, was obtained.

Starches were also extracted from the root crops of taro, sweet potato, edible canna, Irish potato, cassava, and from Guam corn, rice, arrowroot, banana, and tree fern. Results of these experiments are being prepared for publication in bulletin form.

MANUFACTURE OF VINEGARS.

In a previous report of this station[a] a former chemist stated that experiments with pineapple juice were made for the manufacture of vinegar, but that it was found impossible to make a product which would comply with the legal standard requirement for acidity.

Experiments with pineapple vinegar were conducted during the past fiscal year. A pineapple juice, testing 11° Brix, was secured from one of the pineapple canneries. This was heated to boiling, poured into a carboy plugged with cotton, and, on the following morning, inoculated with common bread yeast. Very active fermentation took place, and by the third day the juice had settled. Samples taken on the fifth day showed an alcoholic content of 5 per cent. The product of fermentation was a cider-colored clear liquid which was poured off from the settlings. After some difficulty was experienced in obtaining active vinegar bacteria, a fairly active cider vinegar was secured and mixed with the fermented juice in parts of 1 to 4 and 1 to 8 of the juice. The mixtures were placed in glass vessels having cheesecloth covering. Two and a half months later a very active vinegar fermentation had taken place and a heavy layer of mother of vinegar had formed. The mixture of 1 part to 4 of juice contained 4.2 per cent of acetic acid, and was pronounced of fine quality by local experts: There should be no longer any difficulty in the manufacture on a commercial scale of vinegar from pineapple juice, especially now that active cultures of vinegar bacteria have been secured, and a quick process can be had by means of vinegar generators.

ANALYSES OF FEEDING STUFFS.

The following analyses have been made as the result of considerable interest manifested in the development of local sources of supply of feeding stuffs:

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[a] Hawaii Sta. Rpt. 1913, p. 34.

Chemical analyses of some Hawaiian feeding stuffs.

Feeding stuff.	Water.	Ash.	Crude protein.	Carbohydrates.		Fat.
				Fiber.	Nitrogen-free extract.	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Pigeon pea meal (stem, leaves, and pods)	11.9	2.96	9.21	38.73	34.53	2.67
Coconut meal	10.7	6.09	17.15	11.14	44.13	10.79
Fiber from pineapple stump after starch extraction	10.83	.91	3.5	15.12	68.98	.66
Mixed feed	13.31	8.11	8.57	12.58	54.64	2.79
Brazilian velvet-bean meal (stem, leaves, and pods)	10.20	6.48	6.21	12.69	62.91	1.51
Fiber from good pineapple plant after extraction	9.73	2.07	3.67	17.20	65.74	1.59
Sisal stump	76.7	1.29	.35	7.07	14.26	.33
Cane top meal	7.05	5.85	4.72	31.48	50.05	.85
Alfalfa meal	8.37	3.89	14.86	28.88	41.63	2.37
Mung bean (*Phaseolus radiatus*)	13.06	3.88	24.67	4.41	52.68	1.30

FERTILIZER EXPERIMENTS WITH BANANAS.

During the past three years fertilizer experiments with bananas were carried on; solutions containing fertilizing salts were used as sprays, and various mixtures of the more insoluble fertilizers were applied to the axils of the leaves. In March, 1919, a new planting of about 5 acres was made at Mokuleia, Oahu, and utilized as a large fertilizer experiment. Most of the fertilizer experiments were based on the triangle system which seems to be one of the best methods proposed for this purpose.

The first application of fertilizer was made in April, 1919, and it is planned to make this experiment continuous so that results will be secured on successiye ratoon crops as well as on the first crop. Should a fertilizer producing good results be secured, it will be of great benefit to the grower, who profits principally from the shipment of large bunches of bananas, the smaller bunches being of little commercial value.

FERTILIZER EXPERIMENTS WITH PINEAPPLES.

Fertilizer experiment on pineapples, mentioned in last year's report,[10] made by applying various mixtures of the more insoluble fertilizers directly to the heart of the plants, is progressing and the plants are now producing fruit. Dried blood applied in this manner gave the best results, and a fine stand of fruit, superior to the check rows on either side, is developing. Fish scrap, which was applied in the same manner, produced very dark green healthy plants. Unfortunately, the last application was made at a time when some of the plants were budding and as a consequence the fruit was more or less distorted and injured. Steamed bone meal produced small but positive benefit.

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[10] Hawaii Sta. Rpt. 1918, p. 24.

MANGANESE INVESTIGATIONS

In the report for 1918[11] a description was given of an experiment on manganese soil to which sulphur, at rates of 500 to 3,000 pounds per acre, a red very acid soil at rates of 1 to 6 tons per acre, and bagasse soaked in strong solution of iron sulphate at various rates, had been applied. None of these soil treatments were successful in supplying iron to the pineapple plants, and those on the treated plats became chlorotic at the same time as the checks. After spraying the whole plat with the iron sulphate solution,[12] however, the plants became green and healthy in a short time. It is a fact worth noting that applications of iron sulphate to the soil, at rates varying from 500 to 3,000 pounds to the acre, were unsuccessful in preventing chlorosis, yet the spraying treatment in which considerably less than 50 pounds of iron sulphate per acre was applied to the leaves, promptly cured the chlorosis. The application of the iron sulphate to the soil was effected by soaking bagasse with the iron sulphate, then applying the soaked bagasse and incorporating it in the soil.

REPORT OF THE AGRONOMY DIVISION.

By H. L. Chung.

The agronomy division accomplished good work during the fiscal year 1919, dealing primarily with the emergency food crops for man and animal. The work covered included breeding, fertilizer experiments, variety testing, and distribution of planting stocks of new improved varieties.

CORN.

During the past year two varieties of corn. the Guam and the Cuban Red, have been under test at the station in Honolulu. They represented the two strains selected from a number of varieties for ideal type and yield. The Guam variety produced at the rate of 52.5 bushels to the acre in 1919, an increase of 5 bushels over the crop of 1917–18, while the Cuban Red yielded at the rate of 30.4 bushels.

The Guam variety was characterized by prolificacy, two or three ears appearing on a single stalk. Both varieties, however, were wanting in the desirable length of the ears. This defect, in large measure, was responsible for their low yield. It is thought that constant and careful selection will eventually result in ears developed to the desired length.

While the Guam corn appears to be one of the most resistant varieties to conditions as far as the leaf hopper in Hawaii is concerned, its market possibilities are and will be limited as long as the cosmo-

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[11] Hawaii Sta. Rpt. 1918, p. 24.

[12] Hawaii Sta. Press Bul. 51 (1916).

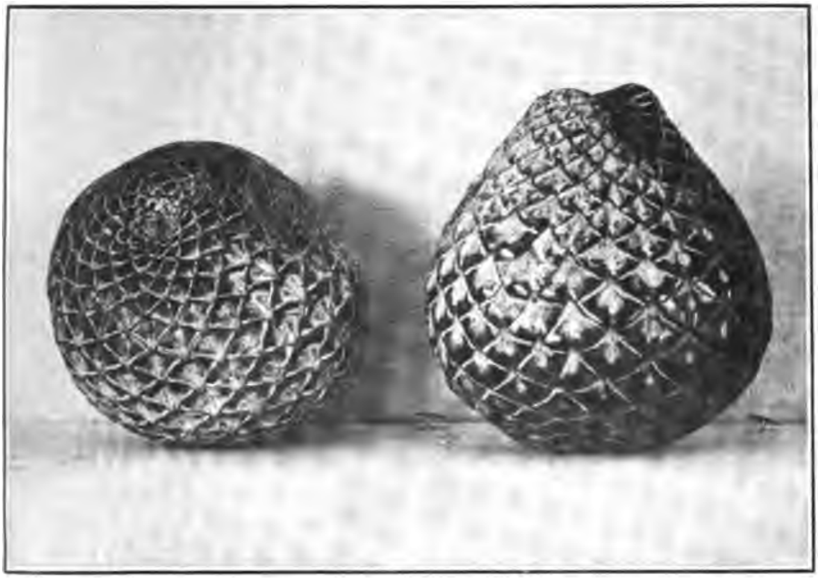

FIG. 1.—FRUIT OF IVORY NUT PALM (CŒLOCOCCUS CAROLINENSIS).

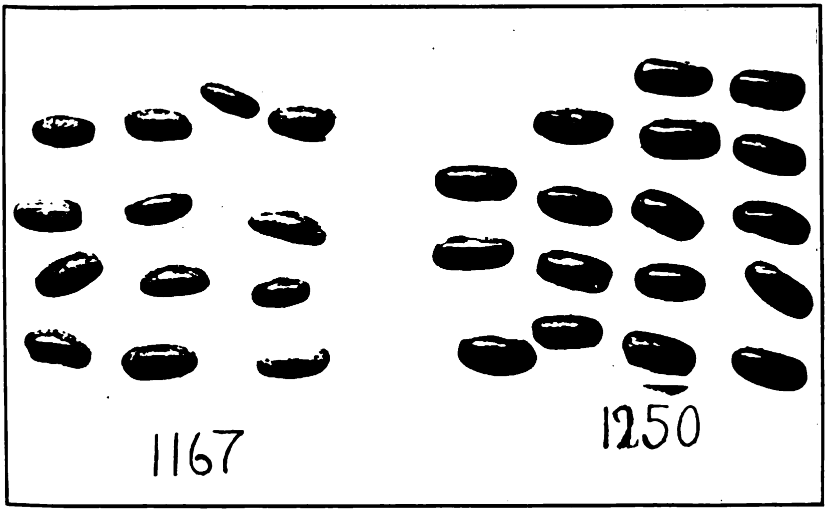

FIG. 2.—A BEAN MUTATION. ORIGINAL ON LEFT, MUTANT ON RIGHT. DARK BLUE GROUND COLOR SAME IN EACH. NO MOTTLING ON MUTANT.

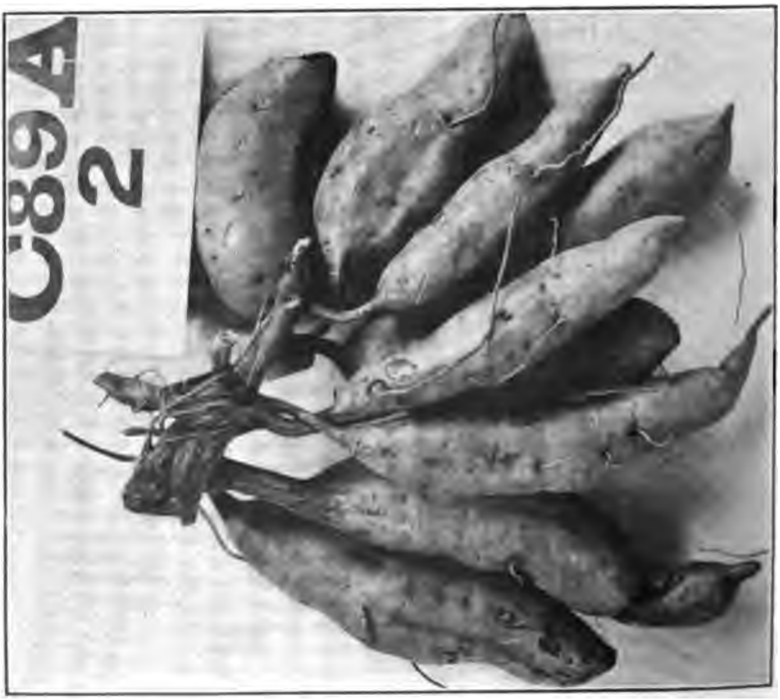

FIG. 1.—A PROMISING SWEET POTATO HYBRID (C89A).

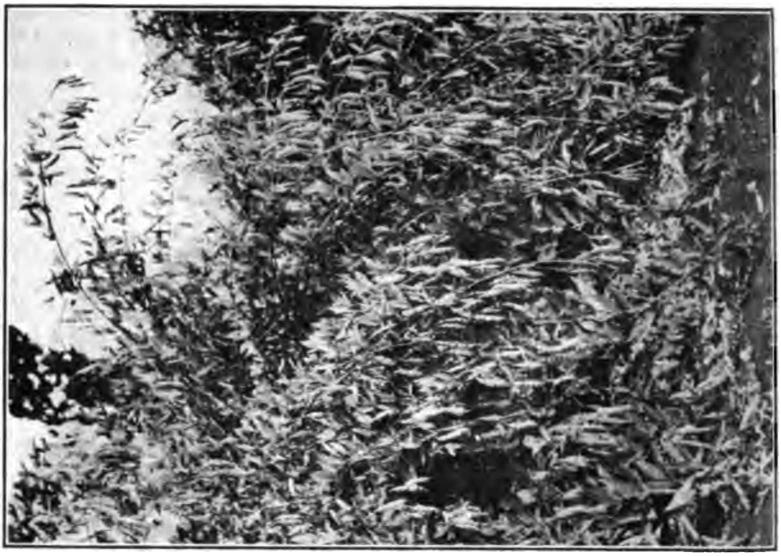

FIG. 2.—HEAVY PRODUCING STRAIN OF PIGEON PEA.

politan population demands a yellow corn. For this reason, the local markets rarely handle any white corn. Because of this peculiar condition the agronomy division is preparing to meet the demands of the future market by hybridizing the Guam corn with some yellow varieties in order to ultimately develop a yellow variety which will possess the desirable characteristics of the Guam corn.

CASSAVA.

A fertilizer experiment on a small scale was carried on in field N at the station. Results are not yet available as the plants are only in their tenth month of growth.

Varietal tests with cassava are also being conducted in the same field, the object being to introduce superior varieties. The tests consist of five varieties, imported from the Philippine Islands through the courtesy of P. J. Wester; horticulturist for the Philippine government, and four varieties from the mainland, selected personally by F. G. Krauss of this station.

The importance of the cassava as a root crop is exemplified by the number of its cuttings, which were distributed in lots of from one to two dozen to individuals. The value of the cassava as a carbohydrate feed for hogs is recognized, the hog raisers of Hawaii frequently requesting from one to nine thousand cuttings of the best varieties.

BEANS.

Since 1917 garden beans of different varieties have played an important rôle in the make-up of small backyard gardens and military company gardens. In fact, the bean was found so important that much time and care was devoted to developing heavy producing strains of the several varieties suggested by the emergency food crop program. Selected beans in lots of from 1 ounce to 1 pound are generally allotted to each applicant to whom the recommendation is made to allow one-half of the crop to go to seed.

Mutation in beans.—A mutation was observed among the Early Refugee variety, No. 1167, a strain harvested after its third generation of growth from selected seeds. The sport of a single plant was discovered among the 200 individual plants when undergoing further selection in the laboratory. Forty-seven of the sport beans were planted. In each generation, and for three successive generations, they reproduced beans identical with the original mutant in physical appearance. Both the parent and the mutant beans showed the same peculiar dark purplish ground work color not possessed by any other lot of beans under test. The dissimilar characteristics between the parent and the mutant (see Pl. V. fig. 2) are summarized as follows:

Dissimilar characteristics observed in beans of parent and mutant plants.

	Nature of growth of plant.	Color of fresh pod.	Color of matured bean.	Length of bean.	Width of bean.
				Inch.	*Inch.*
Parent	Bush	Olive green	Dark purplish blue with light orange mottling.	½	1/16
Mutant	do	Wax yellow	Dark purplish blue	11/32	1/32

Mr. E. J. Mooklar, formerly of this station, tested the edible quality of the sport bean and pronounced it very succulent and tender, when cooked, and one of the best edible-pod beans.

SWEET POTATO BREEDING EXPERIMENTS.

Preliminary work with sweet-potato breeding was begun in December, 1917. The object of this project was to create some new varieties possessing, among other desirable characteristics, early maturity as the predominant feature. While the parents used for this purpose had both good and bad qualities, the work was begun with the hope that by hybridizing certain individuals the desired characteristics could be obtained from some of their seedlings. However, the seedlings produced from the same seed pod revealed the fact that most of the parents used were multiple hybrids. In many cases where three seeds from the same seed pod were planted, three seedlings, each having a distinct leaf pattern, arose. The results expected from such seedlings may not, therefore, be in accordance with the actual realization. The present work gives every indication of promising results. Seedling C89A has proved to be a very prolific individual, having purple and white mottled flesh (Pl. VI, fig. 1). Seedling C111A as an edible is one of the finest varieties of sweet potatoes, being nonfibrous and very mealy.

MISCELLANEOUS CROPS.

Field turnips.—Plantings of the seeds of the round field turnip (*Brassica rapa*), the sample of which was received from Canton, China, were made 18 inches apart in 24-inch rows in field N. When harvested after a growing period covering 18 weeks, the crop gave a calculated yield of 43.5 tons per acre. Individual roots measured 12 inches in diameter and 9 inches in length.

Pigeon peas.—Work on pigeon peas was confined to the growing of seeds selected from high seed-yielding strains (Pl. VI, fig. 2) for general distribution among the poultry raisers. The peas serve as a substitute for corn and other grains commonly marketed as poultry feed.

Dry-land taro.—At the first Territorial fair in 1918 the taro exhibit demonstrated the several ways of successfully growing taro by adapting the plant to climatic and soil conditions of the different localities in Hawaii. The dry-land varieties attracted considerable attention among the homesteaders and landowners whose lands are nonirrigated. This station has received many requests from interested parties for dry-land taro for propagation purposes, but owing to the limited supply only a very small quantity was furnished to each applicant.

CASTNER FORAGE-CROP STATION.

On account of the unusual drought which prevailed at the forage-crop station at Castner progress with some of the introduced forage crops was retarded. In 1918–19 a rainfall of only 30.32 inches, compared with 58.56 inches of the previous fiscal year, was responsible for considerable retardation in the growth of all grasses. As a result some of these grasses died, while others have had a hard time to exist.

ROOT CROPS.

Cassava.—An extensive fertilizer experiment was instituted at Castner during the fiscal year 1918. The cassava was planted April 2, 1918, and will be harvested in September, 1919.

That the drought had a deteriorating effect on the plants is proved by the very poor growth of the cassava. The branches are undersized and the leaves are proportionately small.

Edible canna.—The edible canna was found to be desirable either as a soiling crop or a crop for starch production. Once the plant gets the proper start it will grow without need of further attention.

At Castner 8 plats with hills spaced at 3 by 6 feet were planted to this crop and after 14 months' growth the following data were secured:

Results of experiments with edible canna at Castner.

No. of plat.	No. of hills.	Plat yield.		Calculated acre yield.		No. of plat.	No. of hills.	Plat yield.		Calculated acre yield.	
		Tubers.	Tops.	Tubers.	Tops.			Tubers.	Tops.	Tubers.	Tops.
		Pounds.	*Pounds.*	*Tons.*	*Tons.*			*Pounds.*	*Pounds.*	*Tons.*	*Tons.*
1	4	68.75	40	20.79	12.1	5	4	63	46	19.05	13.89
2	4	73.75	47	22.35	14.21	6	8	104	76.75	15.73	11.6
3	4	68	40	20.57	12.1	7	4	74	40	22.38	12.1
4	4	62	43	18.75	13	8	4	77	47	23.29	14.2

Despite the dry weather the edible canna made a remarkable growth. In the company gardens the plant attained a height of 10 feet where irrigated.

Field beets and field carrots.—Where irrigation can be made available, these two root crops bid fair to become the succulent feed for horses and cattle of the Wahiawa district. The Giant White carrot and Long Red mangel produced roots weighing 6 and 12 pounds, respectively, after a period of 10 months' growth without irrigation.

Potatoes.—The hot and dry weather made the planting of potatoes at Castner impracticable. When attempts were made to plant the Hamakua Hybrid variety under the unusual weather conditions, it was found that the cut potatoes were dried by the intense heat before they had a chance to sprout.

On May 23, 1919, seed potatoes, certified in New York to be blight resistant, were received by the pathological division of this station and turned over to the agronomy division for trial planting. Samples were distributed to the military company gardens for cooperative tests. At the time of this report (June 30, 1919), no sign of blight is to be observed on any of the plants.

LEGUMES.

Annual white sweet clover.—This clover (*Melilotus alba annua*) was sent to this station by Prof. H. D. Hughes, of the Iowa Agricultural Experiment Station, Ames, Iowa. A portion of the seeds was planted at the forage-crop station, where the plants spread well, made vigorous growth, and showed good seed-producing characteristics. This sweet clover will be planted on a larger scale at the station in Honolulu in order to determine its value as a feed for cattle and horses.

Alfalfa.—The attempt to grow alfalfa without irrigation at Castner was unsuccessful. It would be apparently impracticable and decidedly unprofitable for a farmer to try to grow alfalfa on a large scale without the aid of irrigation even in Wahiawa, the farming district immediately adjoining the reservation. The alfalfa at the substation is making very little growth on account of the extreme drought.

GRASSES.

The grass plat experiments at Castner were also handicapped by the extreme drought. Certain of the grasses are evidently drought resistant, since they remain green, yet their growth is stunted and their palatable qualities affected.

Several species of grasses which were adapted to Florida conditions were sent by Mr. J. B. Thompson, of the Florida Agricultural Experiment Station, Gainesville, Fla., for trial planting at this station. Unfortunately the seeds failed to germinate.

The Merker grass (*Pennisetum merkeri*), another grass received from Mr. Thompson, is not only growing very luxuriantly, but is stooling heavily. In physical appearance it resembles the Napier grass (*Pennisetum purpureum*). Data on the yield are not available at this time.

RAINFALL.

The following tabulation gives the comparative rainfall readings in inches for the past two years at the substation at Castner:

Rainfall at Castner substation for the fiscal years 1918 and 1919.

Month.	Year.		Month.	Year.	
	1918-9	1917-8		1918-9	1917-8
	Inches.	*Inches.*		*Inches.*	*Inches.*
July	1.9	1.3	February	0.85	5.8
August	3.9	.96	March	2.4	3.6
September	7.4	5.8	April	.19	9.8
October	1.1	3.6	May	1.1	1.9
November	5.8	3.4	June	1.8	5.8
December	2.9	9.3			
January	.98	7.3	Total	30.32	58.56

DISTRIBUTION OF SEEDS AND CUTTINGS.

During the fiscal year the agronomy division distributed seeds and cuttings to the emergency war gardeners, dairymen, and to ranchers. For the 12 months ending June 30, 1919, seeds and cuttings were distributed to 425 applicants in amounts as follows:

Seeds and cuttings distributed during year ending June 30, 1919.

Crop.	Seeds.	Cuttings.	Crop.	Seeds.	Cuttings.
	Pounds.	*Number.*		*Pounds.*	*Number.*
Alfalfa	32		Sorghum	53	
Beans	107		Cassava		34,529
Corn	480		Uba cane		3,324
Grass seed and cuttings	1,056		Edible canna		5,058
Pigeon peas	72		Napier grass		1,412
Dry-land rice	25		Sweet potatoes		12,771

REPORT OF THE DIVISION OF PLANT PATHOLOGY.

By C. W. CARPENTER.

The division of plant pathology during the fiscal year 1919 continued the program of work set forth in the 1918 report. The Territorial county agents and other extension agencies cooperated with the division, and the pathologist, thus greatly relieved from the burden of extension and demonstration work on insect and disease control, was enabled to devote considerable time to investigation and experimentation activities. With the close of the war it was again found practicable to give attention to important research problems in which immediate practical results were less certain. The manuscript of a bulletin entitled "Potato Diseases in Hawaii and Their Control"[13] was submitted early in the fiscal year for publication.

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[13] Hawaii Sta. Bul. 45 (1920).

TARO ROT.

A preliminary study of the disease reveals the fact that there are several forms of taro rot present in Hawaii. The grayish to brownish rot of the taro corm (the edible underground portion variously called root, tuber, bulb, etc.) is by far the most common and destructive type in the field. The appearance of the affected taro varies considerably, sometimes being gray, soft, and mushy like poi, and at other times more dry and firm and grayish in color, or having merely a brownish discoloration of the tissues adjacent to the large root fibers which traverse the corm. Pathological culture studies of taro rot as it exists in the corm while still in the soil has resulted in the isolation of a predominant organism which resembles *Pythium debaryanum*. Since this latter organism is generally considered responsible for a number of other vegetable rot troubles in moist situations and under favoring conditions,[14] is a parasite of no mean capabilities, there is every indication that this species or a near relative is the cause of the common form of taro rot. It has been previously noted[15] that this organism was found associated with a root rot of rice in Hawaii. A preliminary inoculation experiment with the taro organism resulted in rot of the inoculated taro, while in no case did the uninoculated but otherwise similarly treated taro develop rot (Pl. VII, fig. 1). The taro, kept in moist chambers, sprouted vigorously during the time of rot development, a fact which would indicate continued vitality. Furthermore, that the development of the organism is accompanied by the formation of an enzym is evidenced by changes of the tissues several centimeters distant from the point of inoculation and beyond a point where the organism can be recovered. In the only experiment of this kind attention was directed to these deep and distantly affected tissues and an attempt made to isolate the uncontaminated parasite resulted in failure to obtain the organism.

The organism *Sclerotium rolfsii* was found associated with a rot which occurred in taro several days after it was pulled. Further investigation on the causes of taro rot will be carried on at the first favorable opportunity.

A circular letter on taro rot, furnishing available information to taro growers, was prepared by the pathologist.

Taro rot investigations on Molokai.—A survey of the valley of Halawa, island of Molokai, showed the taro growing there to be in a precarious condition, owing to the presence of a taro rot disease. The rot was of the type previously mentioned as associated with the organism *Pythium debaryanum*. It was thought that conditions would be improved by letting the taro lands rest awhile, or by the practice of crop rotation. However, the suggestions of resting the patches, rotating with rice, or even plowing and harrowing after drying them out, met with little enthusiasm among the planters who make their land serve as the chief means of livelihood. As a result of continuous cultivation covering a long period, the soils have become very acid and otherwise unfavorable to the crop, but it is believed that this condition can be best corrected by plowing up, aerating, and resting the lands, or by planting them to other crops. Since there was no inclination to practice either method, applications of lime were recommended as a practicable way to ameliorate the existing conditions. A small demonstration experiment, carried on in cooperation with the trustees of the Bernice P. Bishop estate, was started on land of that estate in Halawa, in which tests with applications of lime, coral sand, and fertilizer were made. The selected land was a taro patch which, for several years, had grown very little marketable taro, most of which was more or less decayed when pulled up.

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[14] Hawkins, L. A., U. S. Dept. Agr., Jour. Agr. Research, 6 (1916), No. 17, pp. 627-639.

[15] Hawaii Sta. Rpt. 1918, p. 43.

Mr. C. C. Conradt, of Pukoo, Molokai, consented to represent the experiment station in looking after the experiments in Halawa, in addition to acting as collaborator for this station on Molokai, where there is no regular county agent. Data on the results of the experiments are not yet available.

SPRAYING TO CONTROL THE BANANA FRECKLE DISEASE (PHOMA MUSÆ).

The banana freckle disease, described in the 1917 and 1918 reports of this division,[16] continued to do serious damage to the banana industry. As previously noted, this disease affects almost exclusively the Chinese or dwarf banana (*Musa cavendishii*). The disease spots the leaves and fruit; the former prematurely dry and fall, resulting in a general weakening of the plant; the latter appear blackened and disfigured, and unevenly ripen in small bunches.

The larger plantings at Mokuleia, where the bulk of the best fruit is grown, were so threatened by the disease that drastic methods were undertaken in a 100-acre plantation in an effort to check its progress. The pathologist is deeply indebted to Mr. A. J. Campbell, who not only made this cooperative project possible, but maintained throughout the work a keen personal interest and submitted valuable suggestions thereon. The campaign consisted of pruning the trees and burning the affected leaves, removing the upper portion of the stump when a bunch was cut to lessen the infection of the suckers, pulling out the worst affected and otherwise undesirable plants from about 25 acres, and planting cane therein. The more desirable younger fields were retained and sprayed with a fungicide. In the spraying work, attention was directed particularly to the upper surfaces of the leaves.

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[16] Hawaii Sta. Rpts. 1917, pp. 40, 41; 1918, pp. 36-39.

Preliminary experiments showed that Bordeaux mixture would not spread well on the waxy leaves, nor would the lime-sulphur spray. The addition of resin sal soda sticker to Bordeaux mixture, however, proved very satisfactory in overcoming the difficulty. The formula for Bordeaux applied generally in the work is that known as the 4:4:50 formula, though the 4:3:50 and the 5:5:50 formulas were applied to certain plats by way of experiment. The resin sal soda spreader sticker is prepared by boiling 1 pound of resin and one-half pound sal soda in 2 quarts of water until the proper degree of combination is effected. Subsequent experimentation with this formula and others showed that a more workable mixture resulted if the combination was as follows: 4 pounds resin, 2½ pounds sal soda, and 2 gallons of water. Two quarts of the sticker was used with each 50 gallons of Bordeaux.

The Bordeaux mixture was applied with a 100-gallon capacity sprayer, equipped with two lines of spray hose 200 feet long, in 50-foot sections, so that desirable combinations could be readily used, depending on the distance of the plants from the sprayer. (See Pl. VII, fig. 2.) Eight-foot extension rods and small-capacity side-outlet cyclone nozzles were found practicable. Since a relatively long time must be spent on each plant in order to reach the leaves at the proper angle, the small-capacity nozzles were found to give more satisfaction than the larger ones. Temporary roads were constructed wherever needed through the plantation, and portable bridges were made for crossing irrigation ditches, etc.

It was found to be impracticable to thoroughly prune out all infections with a crop like bananas, since plants of various ages were affected, the young suckers becoming infected from the old plants, etc. Too extensive cutting of leaves of plants was found harmful to the fruit, and when attempted on rather young plants, the pseudo-stem later developed such a constriction at the top that the bunch could not issue normally; assisting the bunch to emerge did not result in any material improvement. A similar effect resulted from the pruning brought about by the premature falling of the leaves. It was found, however, that a few leaves could safely be removed, though it was rather difficult and almost impossible to teach the Chinese laborers the discrimination necessary.

As a result of eight months' prosecution of the pruning and spraying campaign on this plantation, there is every indication that the method will be a successful one. The plants throughout are looking very much better than when the campaign started. Conclusions either as to the effectiveness or practicability of the method can not be determined definitely at this time.

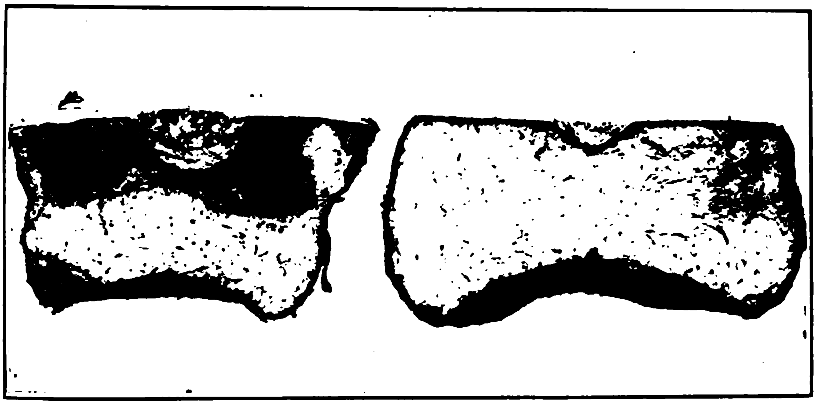

FIG. 1.—TARO ROT DISEASE DUE TO FUNGUS OF PYTHIUM DEBARYANUM TYPE. INOCULATED ON LEFT; CHECK ON RIGHT.

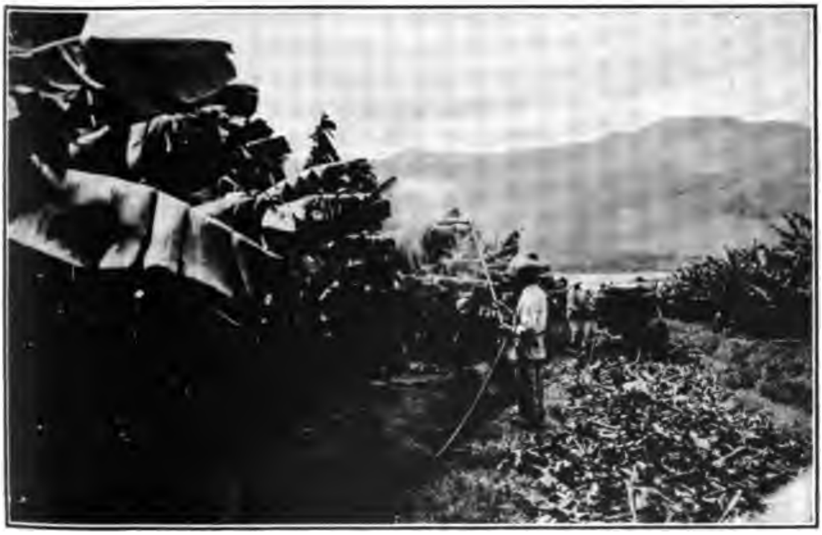

FIG. 2.—SPRAYING BANANAS FOR CONTROL OF FRECKLE DISEASE.

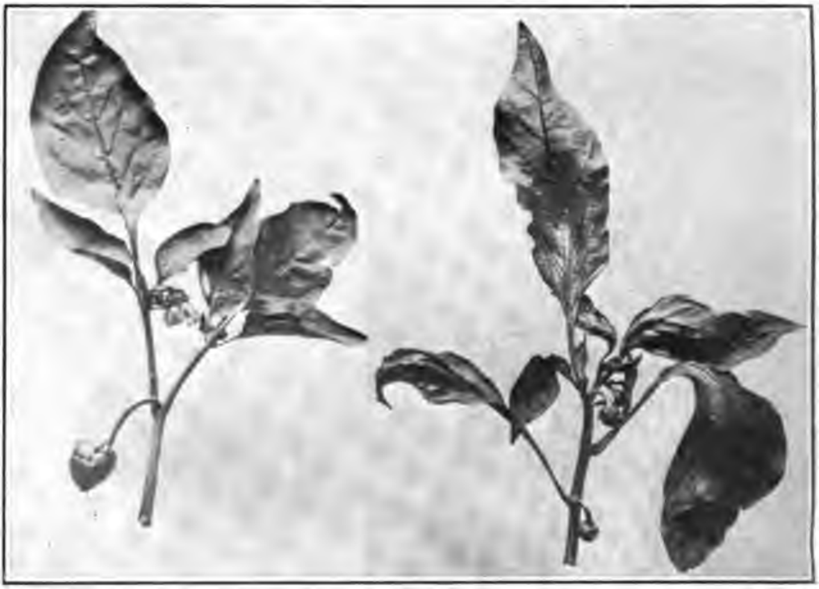

FIG. 1.—CONTROL OF MITE DISEASE OF PEPPERS. SPRAYED WITH LIME SULPHUR ON LEFT; NOT SPRAYED ON RIGHT.

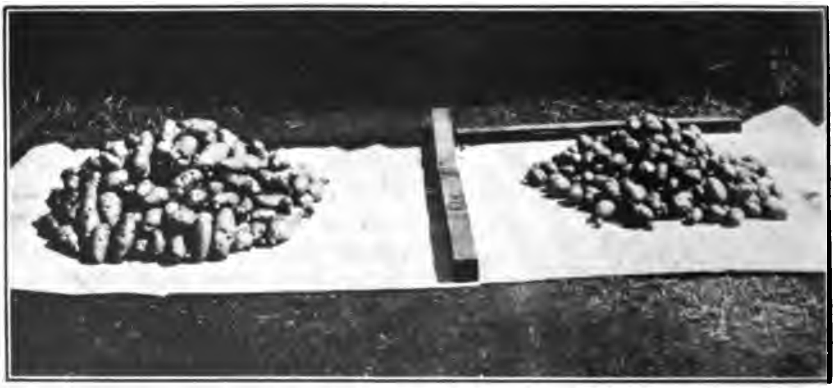

FIG. 2.—CONTROL OF MITE DISEASE OF POTATOES. SPRAYED WITH LIME SULPHUR ON LEFT; NOT SPRAYED ON RIGHT.

Recommendations to prevent the spread of this disease to other banana growing countries were made to the Territorial representative and inspector of the Federal Horticultural Board, and are being well carried out. Since the disease was observed on no island other than Oahu, suggestions were also made to the Territorial inspector to put into force certain restrictions regarding the transfer of banana suckers from Oahu to the other islands.

A MITE DISEASE AFFECTING SWEET PEPPERS.

A peculiar disease condition was noted on sweet peppers growing in dry and hot situations, and is characterized by the curling and stunting of the young leaves and buds. Though little attention has been focused on the disease, examination shows the symptoms to be practically the same as those previously noted[17] associated with mite infestation in the potato and tomato. Numerous mites are present, and the disease and its cause seem to be the same as that known as the potato mite disease. A small experiment carried on with diseased sweet peppers showed that applications of sulphur or lime-sulphur spray controlled the disease affecting them as well as that affecting potatoes. (See Pl. VIII, figs. 1 and 2.)

NEW ROOT-ROT PROJECT.

During the fiscal year the pathologist observed the presence of several very malignant diseases which call for immediate attention. As yet, however, their origin is more or less obscure, and while they have many conflicting symptoms and characters it is quite possible that some may prove quite identical in nature. Certain observations and work made to serve as a basis for a plausible working hypothesis were carried along the lines offering the most promise. This investigation, which is called the root-rot project, will include some studies on the microorganisms of Hawaiian soils.

MISCELLANEOUS NOTES ON PLANT DISEASES.

Among the microorganisms observed during the year and not noted in previous pathological reports are:

Sphærostilbe coccophila.—An entomogenous fungus, apparently parasitic on scale insects which infest the grapevines at Wahiawa, Oahu.

Sclerotium rolfsii.—A stem disease of peanut and affecting taro as storage rot.

Phytophthora calocasiæ.—Found in Oahu, Molokai, and Hawaii on taro leaves.

Cercospora bolleana.—Known as the fig leaf spot, and observed in Oahu.

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[17] Phytopathology, 8 (1918), No. 6, pp. 286, 287.

Sphærotheca pannosa.—Rose mildew, found in Oahu.

Nematodes.—These organisms were found at Pearl City and Mokuleia, Oahu, associated with root rot accompanying the banana center leaf necrosis disease and chlorosis, noted in the 1917 report of this division[18]. In Oahu nematodes were also found associated with the root and crown rot of hibiscus.

REPORT OF THE POULTRY DIVISION.

By L. M. Ross.

During the past several years the major part of the poultry work of the station was conducted at the Glenwood substation, where, under Hawaiian conditions, single-combed White Leghorns were bred specially for egg production. During the past year, however, some attention was given to poultry investigations at the central station at Honolulu. This particular work was carried out with the following objects in view: (1) To ascertain the best system of feeding poultry in the Hawaiian Islands in order to obtain the highest practicable standards of egg production; (2) the development of methods for the most successful brooding and rearing of young poultry; (3) the development of the most effective methods for combating poultry diseases prevalent in Hawaii; and (4) the general encouragement and development of the poultry industry in Hawaii.

SOREHEAD OR CHICKEN POX.

The susceptibility of young chicks to the inroads of sorehead constituted in times past probably the most serious drawback to the successful production of chickens under Hawaiian conditions. Officials of the Territorial board of agriculture and forestry have to a considerable extent overcome this disease by their gratuitous distribution of the proper vaccine. It was found that prompt isolation of suspects, the careful attention to sanitary conditions, and one or two treatments with some suitable antiseptic to the heads of the quarantined birds resulted in reducing the damage from sorehead to negligible percentages. It is thought that unsanitary conditions are highly responsible for the development of conditions which are favorable for the spread of sorehead in poultry flocks. Foul and dirty quarters are probably the most important predisposing factors. In Hawaii certain poultry raisers pay special attention to the provision of sanitary quarters and yards for their flocks; and their young and adult stock have, as a consequence, been free from sorehead. It has been deemed advisable to procure from a breeder foundation stock which has not been subject to sorehead infection, so that this

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[17] Hawaii Sta. Rpt. 1917. pp. 36–42.

stock may not be a carrier of the disease. Strict sanitation should be practiced in such small matters as drinking vessels, roosting quarters, nest boxes, etc., and the poultry should be frequently transferred to fresh runs; the used runs should be plowed, dug, or planted to a crop in order to clean the ground. Where sorehead reached an advanced stage, calcium sulphid was found helpful. One tablespoonful of the powder mixed into a moist mash for each 25 hens should be fed daily until cure is effected.

POULTRY CANKER.

This disease is a very common one in Hawaii. In the course of a preliminary experiment, it was found that the following procedure ordinarily gives relief unless the disease has reached a far advanced stage. The ulcer, and portions of the flesh surrounding it—both inside and outside the mouth—must be painted with tincture of iodin immediately after the canker has been firmly compressed from the outside of the mouth; this compression will greatly eliminate the suppurated matter which is then ejected through the nostrils. Arrangements should be made to have handy a small pan, or other vessel from 3 to 4 inches deep, filled with kerosene oil. Into this kerosene the beak and nostrils of the chickens should be dipped, the head being held there for a few seconds. This operation should be repeated at least three or four times, after which a 1-grain capsule of quinine should be administered to each fowl. If this method of procedure be followed three or four days in succession, the canker will disappear and the chickens will be cured.

COMMERCIAL ASPECTS OF THE POULTRY INDUSTRY.

At the present time the poultry industry in Hawaii is relatively in its infancy, nor is it felt that much increase in the production can be expected until the poultry possibilities are thoroughly demonstrated on a practical scale, and the various drawbacks which now beset the average poultry raiser are overcome. Available statistics show that during the year 1917 some 497,261 dozen eggs, valued at $186,691, were imported into Hawaii from California; during the same year 77,090 dozen, valued at $15,132, were imported from foreign countries, chiefly from China. These figures clearly show that Hawaii holds great possibilities for the disposition of the product of increased poultry flocks in the islands.

REPORT OF THE EXTENSION DIVISION.

By F. G. KRAUSS.

Hawaii produced more food and feed stuffs during that period in which the United States was at war than during any equal period in her history. The agricultural extension division rendered every assistance to the work of stimulating and increasing this production. Throughout the war period close and active cooperation was maintained with the Federal and Territorial Food Administrations. The station's available agricultural data and the demonstrations conducted by it were always at the disposal of the Territorial county agents. Cooperative contacts were maintained with the Territorial agencies at all essential points, a fact which it is thought proved an effective factor in contributing to the excellent results achieved by the islands throughout the war period.

During the months of December and January a trip was made to the mainland of the United States, the journey covering ground as widely separated as California to Massachusetts and Florida. The major object of the trip was to obtain data regarding the production and utilization of cassava, but it was also found possible to get in close touch with the extension activities under way in several of the representative States, and in the United States Department of Agriculture at Washington, D. C. Collections were made of the data descriptive of the most successful methods along extension lines with the idea of adapting them to the peculiar conditions present in the Hawaiian Islands.

EXTENSION SERVICE WORK.

It is felt that a real service was rendered by the division in acting as middleman between the producer of food crops and those sources of information which gave any promise of being helpful to the producer. During the last 15 years cumulative and rather valuable agricultural information was gleaned from the various agricultural institutions and activities of the islands by the superintendent of the extension division. This information was placed at the service of interested parties at the experiment station library, the extension service library, and elsewhere.

In a number of instances plans were prepared for planting and for crop rotation, and working drawings were made for the construction of locally made farm implements, and even for farm buildings and for silos.

The attempt was made to maintain at all times a supply of seed, cuttings, and tubers, etc., of all the improved varieties of crops the increased utilization of which was recommended by the extension division to the island farmers. During the year improved planting stock sufficient for over 1,000 acres was distributed. A large portion of the 40 acres under cultivation was devoted to the production of improved strains of seeds and planting material. Germination and purity tests of seeds were made for those requesting them.

The extension division was also instrumental in arranging for the distribution of approximately 100 young registered Berkshire pigs; this distribution was made at prices which not only enabled the farmer of limited means to purchase the pigs, but also enabled him to secure a foundation stock of superior breeding.

Extended trips through the principal islands were made during the year. By this means close contact was maintained with the more important diversified agricultural projects. Lectures on timely agricultural topics, and demonstrations of spraying, budding and grafting, home curing of pork, and caponizing, were held whenever an opportunity presented itself. Numerous timely articles were prepared for the local press. These articles have always met with a generous and prompt response from the public, and seem a most effective way of reaching the public at large. A neighborhood reading service was in active operation throughout the year. The various agricultural journals received by the extension division were pooled with those subscribed to by others and the entire collection was placed where it could benefit all. Extra copies of agricultural bulletins, etc., which were received by the extension division, were likewise passed along to those interested.

COOPERATIVE EXTENSION ACTIVITIES.

Cooperative relationships were maintained with the other divisions of the Hawaii Experiment Station as well as with the various Territorial and private agricultural institutions. Extensive feeding tests were carried on in cooperation with one of the larger agricultural companies, and, in a number of places, cooperative experiments and demonstrations dealing with special crops or improved agricultural practices were inaugurated. The various local agencies responsible for the school-garden contests, home-garden work, etc., continued to receive the active support of the extension division, as did also the Maui pig club. The superintendent of extension served as one of the judges for the school and home garden contests, and as chairman of the pig-club committee. Likewise, he cooperated actively as a member of the committee of Maui County for the second Territorial fair in Honolulu, and was appointed chairman of the agricultural committee for the Maui County Fair to be held in the autumn of 1919.

The work done in connection with the collaborators constitutes an important phase of the cooperative activities of the division. The collaborator, who represents the division among the farmers of the particular neighborhood in which he is located, ordinarily owns, or, at least manages, the farm on which he works, while the demonstrations conducted by him are usually incidental to his major agricultural operations. During a whole or a part of the year there were four collaborators on the island of Hawaii, two on Kaui, two on Maui, and one on Oahu.

In cooperation with the Territory of Hawaii, the extension division is operating a demonstration farm unit in the newly opened homestead tract on the slopes of Haleakala. The object of this farm is to demonstrate, in the shortest possible time, just what can be profitably produced under the somewhat peculiar conditions of soil, rainfall, elevation, and exposure to winds. The homesteaders rendered very valuable assistance in breaking up the land, while the adjoining ranch generously assisted in the matter of fence construction. The Territorial legislature appropriated money for a small set of buildings, the money to come from the loan fund when there shall be a sufficient balance in said fund to make the outlay practicable.

EXTENSION ACTIVITIES AT THE TERRITORIAL FAIR.

The second Territorial fair at Honolulu offered unusual opportunities for exhibits of the most promising agricultural developments which resulted as an outcome of the intense wartime agricultural activities. The division was largely instrumental in stimulating active and enthusiastic interest among the numerous exhibitors and it entered about 75 individual exhibits, which showed a wide range of products raised on the Haiku demonstration and experiment farm.

One of the principal features of the exhibit of the extension division was its collection of various home-grown feeds suitable for grinding and mixing. This feed was displayed not only to serve as well-balanced rations for every class of live stock, but each feed, in the mixtures designed, was also properly proportioned to suit the needs of the different animals. (See Pl. IX.) It was shown that for various classes of live stock it is practicable to produce and mix home-grown feeds which not only furnish a palatable balanced ration, but which also can be produced at approximately half the cost of equivalent imported feeds.

ENLARGEMENT OF EXTENSION ACTIVITIES ON THE ISLAND OF HAWAII.

Although four collaborators were maintained on the island of Hawaii in connection with the work of the Glenwood substation, it is realized that even a larger working force is required to cover the agricultural work of the largest island in the group. This need was manifested especially when the Territorial legislature withheld its financial support from the county agent system which developed during the war. On April 1, 1919, R. A. Goff, who has for some years been in charge of the substation at Glenwood, was appointed extension agent for the island of Hawaii. He had previously acted in this capacity in cooperation with the Territorial food commission for the region adjacent to Glenwood, as well as collaborating in the extension work of the station.

J. E. Gamalielson, one of the collaborators on Hawaii, is an active poultry raiser and serves as secretary of the Glenwood Creamery Co., a cooperative organization of farmers who market their butter through this agency after supplying local demands. A summary of the creamery business for the last year by months is given below:

Summary of business of the Glenwood Creamery Co. for the year ended May 31, 1919.[a]

Month.	Amount of butter marketed.	Average price per pound.	Total returns.	Cost of marketing.	Month.	Amount of butter marketed.	Average price per pound.	Total returns.	Cost of marketing.
1918	*Pounds.*	*Cents.*			1919.	*Pounds.*	*Cents.*		
June	340	57	$193.68	$10.24	January	358	70	$245.28	$14.32
July	429	54.4	237.65	13.88	February	322	63.04	203.02	12.24
August	402	56	224.94	14.24	March	554	61.37	334.47	15.36
September	420	57	239.26	14.16	April	427	65	277.44	13.44
October	353	57	202.00	13.48	May	435	67	291.45	14.28
November	185	57.8	106.92	7.24					
December	210	70.73	154.89	8.56		4,445	61	2,720.00	[b] 151.44

[a] A summary for the preceding five years was given in Hawaii Sta. Rpt. 1918, p. 28.

[b] About 5½ per cent.

On the farm of Mr. Gamalielson, at Kaumana, Hilo, Hawaii, a flock of about 300 laying hens is maintained not only as a part of the regular business, but also as a demonstration of the possibility of a regular supply of eggs. The production of eggs, by months, is given below:

Egg production for the year ended May 31, 1919.

Month.	Number of eggs produced.	Month.	Number of eggs produced.
1918.		1919.	
June	2,496	January	4,404
July	2,754	February	4,389
August	3,536	March	5,182
September	4,491	April	4,401
October	4,440	May	4,129
November	3,280		
December	3,241	Total	46,743

From the above table it will be seen that there was an average production of 155.8 eggs per hen. The falling off in number of eggs produced in November and December was due to culling the flock.

NEEDS OF THE EXTENSION DIVISION.

Although the division has grown and flourished since its inauguration in 1914, it has many needs. A very apparent need is that of a well-trained marketing agent who not only would be able to attend to the various features of cooperative marketing organizations, but who would also stimulate active interest in farmers' organizations as a whole, as well as devote considerable time and attention to the further development of club work.

The islands also need the development of the farm bureau, which demonstrated its effectiveness throughout the mainland portion of the United States. A properly constituted farm bureau should be organized in every agricultural community throughout the islands, and should correspond in many ways to the chambers of commerce of up-to-date cities. Such an organization would greatly facilitate the work of the county agent, since it would bring him the counsel and advice of the more progressive farmers on the most pressing agricultural problems and their solution.

For the ultimate good of the islands, steps should be taken to increase such various organized projects as boys' and girls' pig clubs, potato clubs, corn clubs, etc. This class of work has heretofore been confined almost exclusively to school-garden work, and as a result of having received a great deal of attention from a number of different agencies throughout the islands, has been an unqualified success. It is felt, however, that the work should be made to embrace more than the production of vegetables; in fact, it should include the systematic raising of farm crops and animals as well. A promising boys' and girls' pig club was recently organized on the island of Maui.

Throughout the islands the ready responses to the home economics demonstrations occasionally made possible by various local agencies clearly proves the desirability of and the need for additional attention to this line of extension work. An efficient home demonstration agent visiting the more or less isolated homes of the island would impart a great deal of up-to-date information and, as an outside influence, serve to increase the happiness and efficiency characteristic of the average individual American home. Each county should have a county agent or full-time representative of the extension division.

HAIKU DEMONSTRATION AND EXPERIMENT FARM.

The Haiku demonstration and experiment farm was originally planned as a demonstration farm. However, a number of local problems developed which could be solved only by actual field and plat experiments. As a result, the experimental features of the work have developed in conjunction with those of the demonstration activities until the two have acquired equal rank on the farm which serves as the base of operations for the extension division. Every theory of practice is first tried out on this farm before it is definitely recommended to the Hawaiian farmer. The practical nature of the demonstrations under way is evidenced by the increase in the number of visitors to the farm. Not only residents of the island of Maui, but also many people from all over the Territory were numbered among its interested visitors.

The experimental work consists in comparative variety tests of new and improved forage and food crops in order to determine their adaptability and possible advantages under local conditions. Cultivation and fertilizer experiments are designed to give definite information as to the best method to be followed for producing those crops which are found to be best adapted.

Another phase of the work is the growing of seed of these crops in order that the improved strains may be quickly disseminated throughout the island. The crops involved in the above work are as follows:

Crops grown at the Haiku demonstration and experiment farm.

Crops.	Number of varieties.	Crops.	Number of varieties.
Cowpeas	16	Grain sorghums	5
Culinary beans	4	Field corn	20
Pigeon peas	4	Popcorn	2
Peanuts	2	Sweet corn	2
Soy beans	12	Cassava	4
Velvet beans	2	Sweet potatoes	2
Alfalfa	10	Irish potatoes	8
Pasture grasses	2	Dry-land taro	20
Forage sugar cane	2	Japanese yam	2
Nonsaccharine sorghums	5	Edible canna	1

In addition to the above-mentioned work with crops, a number of experiments are under way to determine their utilization. The relative merits of the various crops under test are ascertained by feeding them to poultry, swine, dairy cows, and work animals belonging to the station. In addition to these experiments, milling and mixing tests of the various cured products of the farm are made with a view to establishing commercially practicable mixtures of Hawaiian-grown feeds as a substitute for imported feeds.

The hay crops are usually cured on portable curing trucks. The milling of cured hay and grains, including corn, Uba cane, sorghum, cowpeas, velvet beans, pigeon peas, peanuts, cassava, etc., and the mixing of the same to form balanced rations, constitutes one of the most practicable phases of the work and already has resulted in the local establishment of a large commercial milling plant for the manufacture of mixed feeds.

Variety tests, fertilizer experiments, and breeding work with corn.—The work with corn which was inaugurated in 1915, shortly after the establishment of the demonstration and experiment farm at Haiku, continued to broaden in its scope. In the breeding work another variety or strain of corn was developed to supplement the New Era 100-Day Yellow Dent. The new variety, which contains the same blood lines as the older type, possesses them in different proportions and requires a growing season of 20 days longer. This is a favorable feature for localities having ample rainfall.

When the writer was in Washington, D. C., during the past year, an experiment was arranged in cooperation with the office of Corn Investigations of the Bureau of Plant Industry, United States Department of Agriculture, to compare, by testing, a number of varieties of corn at different elevations with those already under test. The following mainland varieties are under test in direct comparison with the New Era 100-Day Yellow Dent and the local Kula type of corn: Mill Pond Prolific, S. P. I. No. 45903, U. S. Selection 119, Taxpan, No. 133, and Johnson's Prolific. These were planted at an elevation of about 500 feet at the Haiku demonstration and experiment farm, March 21–23, 1919. The corn, carried as No. 133, harvested June 25, was the only one having ears which matured during the fiscal year just closed.

The yield of No. 133, from a plat one-third acre in size, was at the rate of 40 bushels per acre, despite the fact that it was planted rather late in an unduly dry season. A second planting was made at the Haleakala demonstration farm at an elevation of about 2,000 feet, and a third planting was made at Waiakoa (Kula district) at an altitude of about 3,000 feet. These plantings are not yet sufficiently mature to justify any definite comparison.

In addition to the above-mentioned cooperative experiment, variety tests with the following varieties are being continued: Blount's Prolific, Casey's Purebred Old Virginia Shoe Peg, Virginia White Dent, Cocke's Prolific, Boone County White, Silver King, Improved Paymaster, Improved Southern White Snow Flake, Eureka, Bigg's Seven Eared, Hickory King, Wood's Gold Standard, Improved Golden Dent, Reid's Yellow Dent, Improved Leaming, Virginia Yellow Dent, Victory Yellow Dent, Virginia Ensilage, Pamunkey Ensilage, and Improved Yellow Creole. The writer selected the last-named variety in Louisiana during the winter of 1918–19.

The fertilizer tests have proved that it is absolutely essential to apply phosphate fertilizers in order to obtain a profitable yield of corn. The most economical results were obtained from those plats where a mixture consisting of equal parts of reverted and superphosphate had been applied at the rate of 500 pounds per acre.

Pigeon peas.—Probably the most important demonstration of the possibilities of a species relatively new to the islands as a field crop was that of the 15-acre field of pigeon peas first planted in March, 1917. Over a hundred other forage crops were tested, but the test with pigeon peas seemed to combine more good points with less unfavorable characteristics than any other crops which have been under observation. The fields were cropped from three to five times for seed and forage. (See Pl. X, figs. 1 and 2.) The product was cured as hay, which in turn was milled into meal and fed to all classes of live stock. As a result of this demonstration conducted by the station a neighboring rancher planted 350 acres. Part of this planting is now being harvested, milled in a well-equipped milling plant, and fed extensively to live stock on his ranch. It is estimated that probably 1,000 acres were planted in the Territory during the past two years, most plantings having been with seed bred especially by the Haiku demonstration and experiment farm for seed yield and other good qualities.

Alfalfa variety inoculation and fertilizer tests.—Previous to the year 1907, several unsuccessful attempts were made to establish stands of alfalfa. Even where the soil was well prepared, the young seedlings succumbed before attaining a height of more than 4 inches. Heavy manuring would have helped somewhat to overcome the difficulty, but owing to the limited quantity available this means of fertilizing was impracticable. In January, 1917, a combined variety test, inoculation, and fertilizer experiment was inaugurated with 4 strains of ordinary alfalfa, 2 strains of Peruvian, 2 strains of Grimm, 4 strains of Siberian, and 1 strain of an alfalfa received under the name of Liscomb. Plats that received the pure cultures (commercial) of tubercle organisms showed no appreciable improvement over the checks. One ton of hydrated lime per acre failed to show any benefit. Sulphate of potash, applied at the rate of 250 pounds per acre, gave no beneficial results. The plats which received a combined application of 100 pounds each of dried blood and nitrate of soda gave a very poor growth, little, if any, better than the check plats, and the plants finally died, as was the case with the checks. Stable manure when applied at the rate of 20 tons per acre resulted in a fair growth. The best results were obtained from the plats which received an application of 500 pounds of a mixture of equal parts of reverted phosphate and superphosphate. From the start the growth and development were excellent, a fact which indicates clearly that the only need of the soils in question was that of phosphate fertilizers.

The applications of phosphate fertilizers were repeated in January, 1918, and again in January, 1919. Notes on the relatives merits of the different strains and varieties were made in connection with plats receiving applications of phosphate fertilizer. The alfalfas were seeded January 3, 1917, at the rate of 8 pounds of seed per acre in drills 18 inches apart. A mixture consisting of 500 pounds of equal parts of reverted and superphosphate was applied in the drills at the time of planting. The soil was raw guava upland from which one plant and two ratoon crops of pineapples had been harvested. This is one of the most unfavorable types of soil and its history has not been such as to warrant putting the soil in good condition. The varieties are arranged in the order of their apparent merit under the conditions, the best being placed first. The hairy type of the Peruvian alfalfa proved to be a vigorous upright grower, which recovered quickly after each cutting. The yield was 28 tons of green forage per annum from 12 cuttings. The smooth type of Peruvian alfalfa blooms from four to seven days later, and gives from 10 to 11 cuttings per annum, with a yield of green forage weighing about 25 tons. This variety, because of its smoothness, is usually more favorably regarded than the hairy type. The ordinary alfalfa was represented by four regional strains (Texas, California, Utah, and Idaho). These all did well under trial. Their leafage is more dense and in habit they are more spreading than the Peruvian type. They mature later, also. An average of eight cuttings, aggregating 20 tons of green forage per annum, was obtained. The variety received under the name of Liscomb did not differ materially from the common alfalfa. The two strains of Grimm alfalfa proved to be slow growing, somewhat stunted in habit, with small dense foliage. The yield was about 10 tons of green forage per annum. Under ordinary conditions in the islands this variety can not be recommended for hay; however, it may prove valuable for pasturage, especially under somewhat unfavorable conditions at the higher altitudes.

The Siberian alfalfas (Cossack, Orenburg, Cherno, and Semipalatinsk) were placed under test. While they are of too spreading a growth to be well adapted for hay-producing purposes they may prove valuable as pasturage where grown under unfavorable conditions of soil and moisture, as at the higher elevations where any palatable legume that will survive is to be favorably regarded. In the variety tests the yield ranged from 10 tons of green forage for the Cossack strain to less than 5 tons for the Semipalatinsk. The Turkestan variety made a poor showing and its culture is not recommended.

Experiments with potatoes.—This year marks the close of a four-year field experiment with potatoes. This experiment included comparative tests of numerous varieties, together with fertilizer and cultural experiments. The ordinary Kula (Maui) potatoes were formerly noted for their fine quality and fairly abundant supply in the Honolulu market. During recent years, however, both the quality and quantity have decreased to a marked degree. With a view to

PLATE IX.

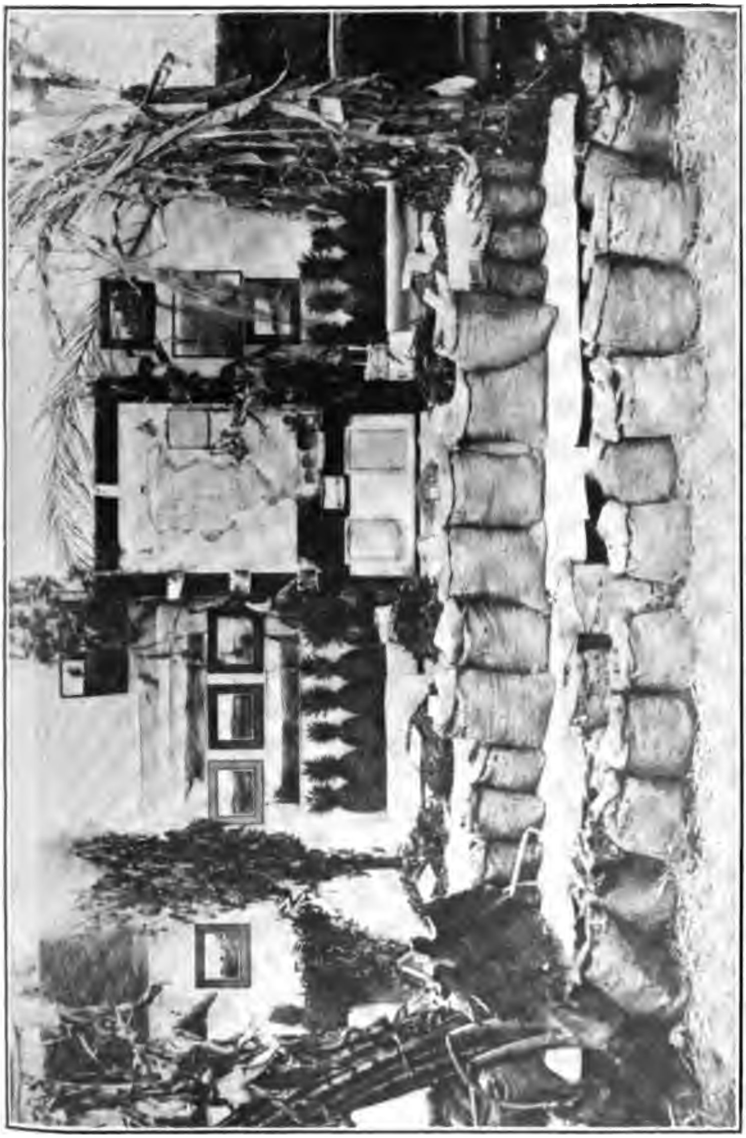

Exhibit of Products Grown in Cooperation With the Station, Showing the Possibilities of the Development of a 40-Acre Unit in 5 Years. Corn, Pineapples, Pigeon Peas, Taro, Sugar Cane, and Home-Grown Mixed Feeds for Live Stock.

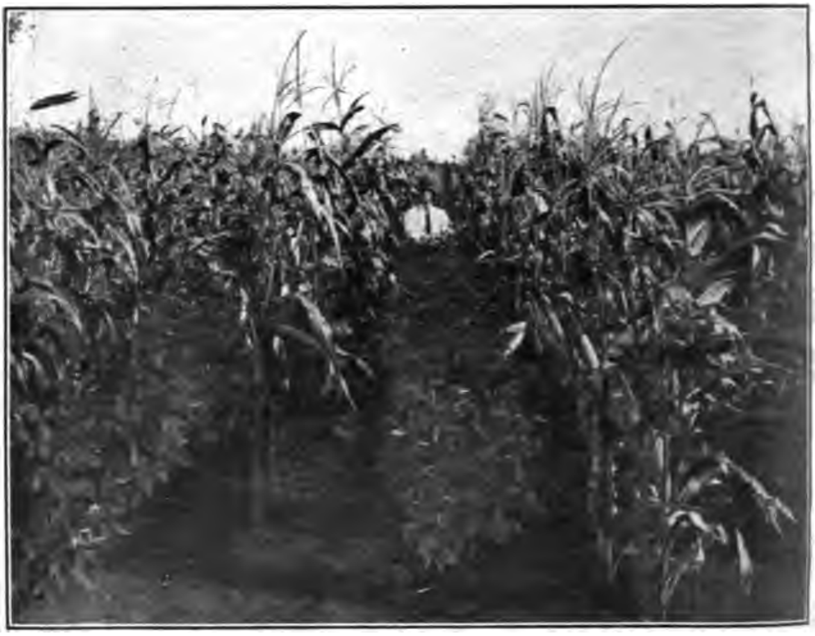

FIG. 1.—PIGEON PEAS INTERCROPPED WITH CORN. PEAS CONTINUE TO OCCUPY LAND FOR 3 TO 5 YEARS.

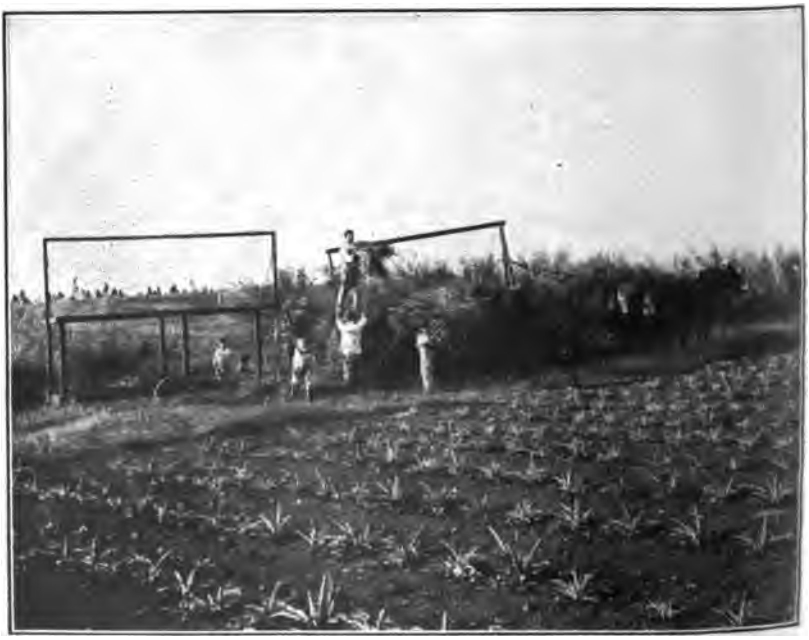

FIG. 2.—HARVESTING AND CURING PIGEON PEAS ON HAY-CURING RACKS. PINEAPPLES IN FOREGROUND ROTATED WITH PIGEON PEAS.

rehabilitating the growing of this important food crop, restoring it to its former status, and, if possible increasing its importance, there was instituted in 1915 a rather comprehensive series of potato experiments. It was clearly shown that the best tilth possible should be provided on rather heavy soils. In order to maintain a fairly mellow condition of the soil throughout the growing season it was found necessary to incorporate in the soil a liberal amount of organic matter. The most practicable method of doing this proved to be that of turning under one or two good crops of velvet beans or cowpeas. About 25 tons of green matter per acre, when turned under, will ordinarily suffice to supply the requisite amount of organic matter in the soil.

It has been found from experience covering four successive seasons' plantings that to secure profitable yields it is essential to supplement the green manure with a liberal application of commercial fertilizer. A comparative test of the standard chemical fertilizers available in Hawaii showed conclusively that the phosphatic fertilizers are the controlling factor in maintaining a high degree of soil fertility. It was also found that potatoes respond to such fertilizers as readily as do corn, alfalfa, and other crops which, without the application of phosphate in some form, are practically failures. An application of 500 pounds of either superphosphate or reverted phosphate, placed in the hills at the time of planting, gave an increased yield of from 150 to 400 per cent over the untreated plats. Finely gound bone meal also gave satisfactory results.

In planting potatoes the best results were obtained where 2-ounce seed pieces, bearing at least two eyes, were used, the planting being made when the newly sprouted shoots were about one-quarter of an inch long. The potatoes were placed to sprout in single layers in subdued light where they were kept fairly cool by suitably controlled ventilation. Before planting, the seed was treated for scab, the whole tubers being immersed in a solution of formaldehyde, 1 pint to 30 gallons of water. It was also found that 4 ounces of corrosive sublimate to 30 gallons of water made an efficient dip. The seed was planted at 18-inch intervals in rows 30 inches apart, thus giving 11,616 hills per acre. About 1,500 pounds of seed per acre was used. In moderately dry seasons, plantings were made at from 4 to 5 inches in depth, but in moist seasons the seed was planted from 2½ to 3 inches deep.

One of the most critical problems in connection with the production of potatoes was that of eradicating the so-called blight and attacks from the recently noted mite and aphis. While these were responsible for considerable losses, methods have since been developed for safeguarding the crop by the use of Bordeaux-lime-sulphur spray and nicotin preparations in adequate amounts. Such treatments add invariably to the cost of production, yet their very efficient results justify their use.

It is concluded that a lack of care in protecting the island's newly dug potatoes from sunshine is directly responsible for their poor keeping qualities. It is important that potatoes be placed in a cool dark storage as soon as they are dug. One of the varieties, when subjected to this treatment, kept in perfect condition for eight months. During the past two years the planting stock was grown from hill selected seed. The station's highest yielding variety gave an average yield of 1½ pounds per hill, but numerous hills yielded as high as 5 pounds of potatoes. It is regarded as fully established that carefully selected seed from individual hills will produce larger and more uniform crops than the general run of stock. The extension division has on hand a stock of selected seed potatoes of the New Era strain of Earliest of All, Producer, Snow, and White Rose. These are available for distribution to those planters who desire to test them, report on the results of the test, and, upon finding the varieties a superior kind, produce them in their own localities. The results of the potato variety test are shown in the table given below. No variety is included which for at least three seasons was not grown under field conditions. The range of yield in a variety during the different seasons has been as high as 40 per cent. The New Era Earliest of All yielded at the rate of 300 bushels to the acre, although the average yield was approximately 170 bushels per acre. During recent years yields as high as 170 bushels per acre under local conditions were very exceptional, even in the potato-growing districts of the island of Maui. In the Burbank varieties the low average yield was due to their late maturity and consequent susceptibility to blight and mites. These, on several occasions, have cut the crop short when otherwise an excellent yield would presumably have been obtained.

Results of potato variety tests at Haiku demonstration and experiment farm, showing approximate average yields, in pounds per acre, based on three or more crops.

Relative rank of variety.	Variety tested.	Approximate average yield per acre.	Relative rank of variety.	Variety tested.	Approximate average yield per acre.
		Pounds.			*Pounds.*
1	Earliest of All	10,200	13	Early Prizetaker	6,400
2	Producer	9,600	14	Gold Coin	6,200
3	Snow	8,350	15	Kula White	6,150
4	White Rose	8,100	16	Kula Flat	6,050
5	Bliss Triumph	7,700	17	Scotch Rose	6,000
6	Early Rose	7,600	18	Burbank, low top	5,950
7	Early Sunrise	7,400	19	Burbank, high top	5,400
8	Early Freeman	7,350	20	Burbank, Kula seed	4,650
9	American Wonder	7,250	21	Hamakua Hybrid (Kula, Kim strain).	4,600
10	Green Mountain	7,000			
11	Pride of Multnomah	6,500	22	Hamakua Hybrid (Yamata strain).	3,800
12	Netted Gem	6,150	23	Hamakua Hybrid (New Era strain	3,250

The division, basing its work on the results obtained in this variety test, is now using only the first five varieties listed, with the single exception of a select strain of low-top Burbank, which is to receive further trial. The earlier varieties, which usually escape the blight and mites, do decidedly better than the later-maturing sorts. After three years' effort, the selection work carried on to establish a variety immune to the blight has resulted in failure. It is thought that the best practice now available on Maui is that of growing early varieties best suited to the conditions and spraying them several times during the latter half of the growing season. These suggestions are made with special reference to the island of Maui, because there the conditions materially differ from those obtaining elsewhere in the Hawaiian Islands.

The cost per acre of growing a 100-bag (167 bushels) crop of potatoes at the Haiku demonstration and experiment farm was approximately $150. This includes rental of land, expense for tillage, seed, planting, harvesting, storage, etc. The crop, at present prices of $3.50 per 100 pounds, however, will be a profitable one if the yields produced by these best varieties can be maintained. When the yields fall to 50 bags (83 bushels) per acre, which is more than the average yield in the potato-growing districts of Maui, the profits are very small, although the cost of production is less there than in the Haiku section. A series of cooperative experiments in potato culture, the object of which is to demonstrate the most profitable methods of increasing the potato yield in those districts, is also in progress in the Makawao and Kula districts of Maui.

Pineapple experiments.—The pineapple experiments cover a tract of 10 acres; the first crop of this fruit was harvested at the close of the fiscal year. The experimental data, which require that each fruit be weighed as picked, necessitate as many as 2,500 individual weighings in the course of a single day's operations.

Tests with starch-yielding plants.—A considerable number of trial plantings were made with plants which, it is hoped, will ultimately become sources of commercial starch. These plantings included edible canna (*Canna edulis*), and several varieties of cassava, sweet potatoes, and taro. The observations, made in connection with a trip to the mainland during the year just closed, indicate the possibility of commercial production of starch on a large scale. Such an industry, once established in the islands, would constitute another of the diversified industries; and the residual product of these plants, after their starch had been extracted, would become an important source of economic carbohydrate stock feed.

REPORT OF THE GLENWOOD SUBSTATION.

By R. A. GOFF.

The economical growing of food and feed crops continued to be the principal object of work done at the Glenwood substation during the past year. Purebred single-comb White Leghorn poultry was kept and eggs for hatching purposes were distributed throughout the island. While experiments with a number of promising crops were carried on, the work was mainly centered on potatoes, beans, cabbages, corn, and alfalfa. Unfavorable climatic conditions make it very difficult to produce many of those crops which are easily grown in other parts of the Territory. It was conclusively demonstrated that these five crops can be successfully grown in this district, and, in order to increase their yields, this station has tried to find better cultural methods.

The superintendent devoted much of his time to visiting homesteads and plantations in the Kau, Puna, Hilo, and Hamakua districts, assisting the farmer in every possible way by the distribution of seed and by imparting information, and in establishing fields of alfalfa.

The Glenwood substation, which was conducted principally with Territorial funds, received during the past year some assistance from the Federal Experiment Station in Honolulu, which paid the wages of two of its laborers.

IRISH POTATOES.

Three varieties of potatoes were planted, the Hamakua Hybrid (both red and white strains), the Portuguese Red, and Pride of Multnomah (an Oregon seed potato). The Multnomah, which consistently and repeatedly proved to be nonresistant to blight, has, therefore, been a failure in this district, where spraying is prevented by rains. The Hamakua Hybrid and Portuguese Red have made good yields. Marketable potatoes in yields of from 90 to 120 bags are usually obtained, and since they sell at from $2.35 to $3 per bag a good profit is usually realized from them. During extremely wet and cold years only one crop can be grown and the yields are lower, but in 1917 and in 1919 potatoes yielded well in this district.

In somewhat limited fertilizer tests with the Hamakua Hybrid, in which superphosphate and nitrate of soda, applied singly and in combination in varying amounts, and stable manure were compared, it was found that the use of equal amounts (250 pounds each per acre) of superphosphate and nitrate of soda was most economical.

SWEET POTATOES.

Twelve varieties of sweet potatoes, which were found growing in the Hilo and Puna districts, were planted. Of these five died and six grew slowly; the Laupuuwai, however, which made rapid growth and as yet has not been attacked by the leaf miner, is thought to be an excellent variety for this locality. The Madeira and New Era varieties produced well, but required over a year in which to mature.

MAUI RED BEANS.

The table below shows the results of a fertilizer experiment on eight plats, each 675 square feet, planted to Maui Red beans:

Results of fertilizer experiment with Maui Red beans

Plat No.	Fertilizer applied per acre.	Yield per acre.	Plat No.	Fertilizer applied per acre.	Yield per acre.
		Pounds.			*Pounds.*
1	Superphosphate, 500 pounds in 2 equal applications	1,400	4	Superphosphate, 250 pounds	1,195
			5	Stable manure, 20 tons	1,800
2	Check, no fertilizer	780	6	do	1,975
3	Superphosphate, 500 pounds in 2 equal applications	1,235	7	Check, no fertilizer	930
			8	Stable manure, 30 tons	2,030

It will be observed that stable manure gave the highest yields, but where a sufficient quantity can not be had for field planting, good yields may be obtained from the use of superphosphate alone.

DRY-LAND TARO.

Three varieties of taro, the Kuoho, Olaaoloa, and the Ala, were planted in February, 1919, and are doing better than any previously planted. The keiki, or sucker plants, are forming, and the crops should be ready to harvest by January, 1920. This is a somewhat longer growing season than is necessary at lower elevations, but a number of local growers have begun to plant taro where potatoes and cabbages do not thrive.

LICORICE ROOTS.

Roots planted in May, 1918, were a failure, since, after making a growth of three months, they died.

IMPROVED POHAS.

Records have been kept of the yields from the two plats of pohas which were planted in May, 1918. One plat contained the poha found growing wild in the woods; the other was planted to an improved giant variety obtained from Philadelphia. The native poha is perennial, and the pickings may be extended throughout the year.

The improved variety bears for a short season then dies. The native poha yielded 8 tons to the acre and the improved poha yielded 2½ tons to the acre. The improved variety is a much larger fruit, and, while only 40 pounds of the native poha can be picked and prepared for market in a day, over 200 pounds of the improved variety can be easily prepared. Both varieties make excellent jam. Where cultivation of the improved variety is unnecessary this fruit should become a paying crop.

ALFALFA.

In the substation plats alfalfa yielded from 20 to 30 tons of green feed to the acre and can be cut 9 times a year. The fields are still developing and should, after another year, produce even better yields. At lower elevations in the north Hilo district, fields, planted under the supervision of the superintendent and cut 11 times in 12 months, are growing stronger after each cutting. Various methods of planting were tried, but the one found most suitable to local conditions of climate and weed growth is that of drilling the seeds in rows 2 feet apart. After 6 months' time the plants usually cover the ground and check weed growth, so that rather infrequent cultivation is required. When growing alfalfa it is very essential to have the fields in which it is to be planted as nearly weed-free as possible. The substation is keeping track of the costs of planting and bringing the crop to the first cutting stage, but as yet these data are not complete. Cooperative experiments in the planting of alfalfa were started in 12 localities on the east side of this island and so far are promising.

SWEET CLOVER.

Sweet clover is a slow-growing plant in this district, is not seriously attacked by insects, and produces nearly as well as alfalfa. It is an excellent feed for dairy cattle, grows on soils too poor for other legumes, and when turned under enriches the soil.

CORN.

Three varieties of corn, Waimea White, Guam, and Cuban Red, have given good yields, the Waimea White doing the best of the three. In the Glenwood district stable manure is a splendid fertilizer for fields planted to corn, and phosphate fertilizer gives almost as good results. In a comparative fertilizer test with Waimea White, stable manure gave a yield of 2,600 pounds of corn to the acre; phosphate, applied just before planting, at the rate of 400 pounds to the acre, gave a yield of 2,415 pounds of corn. Nitrate of soda and complete fertilizers, which are more expensive than phosphate, gave lower yields and can not be recommended. The average yield per acre of the three varieties was as follows: Waimea White, 2,415 pounds;

Guam, 1,650 pounds; and Cuban Red; 1,200 pounds. Guam corn doubtless would do as well as or even better than Waimea White at lower elevations, and Cuban Red, which has the advantage of being hardier and more resistant to pests, can be grown where other varieties do not give good yields.

SORGHUM.

Texas Blue Ribbon, Early Amber sugar cane, kafir, Egyptian wheat, and feterita were planted in order that a green feed for dairy cows might be secured. It was known that these would ratoon and in this way eliminate the necessity of replanting after each crop. Because of heavy rains it is often difficult to plant corn in the proper season, and if the sorghums can be made to ratoon well, they will prove of inestimable value to local dairymen. In Hawaii all of these varieties mature seed which probably would become a source of poultry feed were some method to be found which would prevent birds from eating the maturing grain. The crop, secured from planting seed, averaged 22 tons of green feed to the acre, but the ratoon crops so far have been stunted and have not been used for fodder because of the possibility of their poisoning the cattle. As the sorghums continue to ratoon after each cutting, different fertilizers are being applied in an effort to secure a quick-growing, heavy second growth.

EDIBLE CANNA.

The edible canna which was introduced as a substitute for potatoes is now more largely used as a hog feed. At this elevation it produced 7 tons of roots to the acre with a nine months' growing season, but matures more quickly at lower levels. When well fertilized, the tops grow to a height of 8 or 9 feet; these tops, after being cut in 6-inch lengths, are fed by local growers to hogs. The roots as well as the tops are relished and furnish a large part of the ration; the latter, when mixed with 2 pounds of soured rice bran, cause the hogs to steadily increase in weight. Small fields of canna are kept growing at the substation and cuttings are distributed among homesteaders.

CASSAVA.

Cassava, from which tapioca is made, makes a rapid growth in the Puna district of this island. Cuttings were secured from that place and planted at the substation in the late autumn of 1917. It failed, however, to reach the size of plants 5 months old at the lower elevation. Waialua White and Trinidad varieties were also planted and are maturing slowly. A very good grade of edible starch can be made by grating the roots, and, after mixing them with water, straining them through cheesecloth. The value of these roots as a hog feed is being recognized by many growers to whom cuttings were distributed.

PIGEON PEAS.

Pigeon-pea bushes grow to a height of 5 and 6 feet in the substation plats, and, although they do not mature seed, their younger branches, when cut off and ground, furnish a palatable feed for dairy cows. Since they are legumes, they have the added advantage of enriching the soil, especially when turned under as a green manure crop. Seed which was distributed to farmers in the vicinity of Hilo has developed into plants which are now bearing seed. The pigeon-pea crop is highly prized by those who have raised it.

GRASSES.

Demonstration plats of Kentucky blue, awnless brome, redtop, timothy, orchard, crested dogstail, Italian rye, and meadow fescue grass, planted in 1917, continued to grow well throughout the year. Originally planted in rows 3 feet apart, the redtop and Kentucky blue grass have spread until they now cover the ground and form a heavy mat; this feature makes the grasses valuable additions to the pastures of this district. Less than an acre of *Paspalum dilatatum*, or Australian water-grass, which was planted in 1916 from roots set in 2½-foot rows, furnishes all of the grazing needed for one dairy animal, since it has spread until the ground is almost entirely covered. Six acres of the native or wild grass is necessary to supply grazing land for one animal, so that Paspalum is easily worth five or six times as much as the grass found in the majority of local pastures. This station secured seed of these grasses for local dairymen who desired to improve their pastures. Twelve varieties of grasses and leguminous plants from Florida were planted in the field and in flat boxes, but failed to germinate.

POULTRY.

Purebred single-comb White Leghorn poultry has been kept, and eggs for hatching were distributed throughout the island at a nominal price. The entire flock netted a return of 26 cents per bird per month above cost of feed. At the same time, the flock supplied the hatching eggs used at the station and paid for the feed used by over 300 growing chicks. The hens of the entire flock average 12 eggs per month. The feed cost of each hen is 30 cents per month; the return above feed cost, when the eggs are sold on the market, is over 40 cents per bird. It has cost the station 85 cents on the average to bring a pullet to the age of 3 months, exclusive of the labor required, and about $2 to care for it until the time of laying. Poultry raising should become profitable in the Territory where small flocks are kept as a side line or in larger flocks of about 500.

COOPERATIVE EXPERIMENTS.

After demonstrating in experiment plats that phosphate fertilizers as well as complete fertilizers return large yields of potatoes per acre, arrangements were made with a Glenwood farmer to carry on a cooperative fertilizer experiment on his land. An acre was divided into eight equal plats to one of which a complete fertilizer was applied by the farmer at his usual rate of application. Another plat was reserved as a check plat where no fertilizer was applied; and in the other six, reverted and superphosphate were applied by the substation at the rate of 250, 500, and 1,000 pounds per acre. A second application of 150 pounds per acre was given to the plats which had received 250 pounds. The potato rows were about 40 inches apart and the fertilizer was applied in the rows and not scattered broadcast. At harvest time it was found that all the fertilized plats returned a 30 per cent larger yield than the check, and that the plats in which 400 pounds of phosphate had been used gave as large yields as the one in which the more expensive complete fertilizer had been used. Practically all of the potatoes planted in Glenwood this year have been fertilized with phosphate at a considerable saving to the planters as a result of the experiment, and all indications point to a larger yield than in previous years. The superintendent has ordered all the phosphate for the local growers, and will continue to do so until satisfactory arrangement for their purchase can be made with local dealers. On various farms demonstrations were also made of the use of poisons for cutworms, cabbage worms, potato blight, and sweet-potato leaf miner. Assistance was given to homesteaders in the purchase of reliable seed and poison for the various pests.

SCHOOL-GARDEN CONTESTS.

The superintendent acted as judge in the Star-Bulletin school-garden contest in the districts of Puna and Kau and in the final judging in the Kona district. He also served as judge in the Hilo Board of Trade home-garden contest.

BOYS' WORKING RESERVE.

The superintendent for four months acted as county director of the Boys' Working Reserve work on this island and for nine months had charge of the work on the east side. A trip was made around the island of Hawaii with G. A. Young, the executive secretary of the reserve in the Territory; a motion-picture machine was used to give exhibitions, and in each of the districts a practical talk was given.

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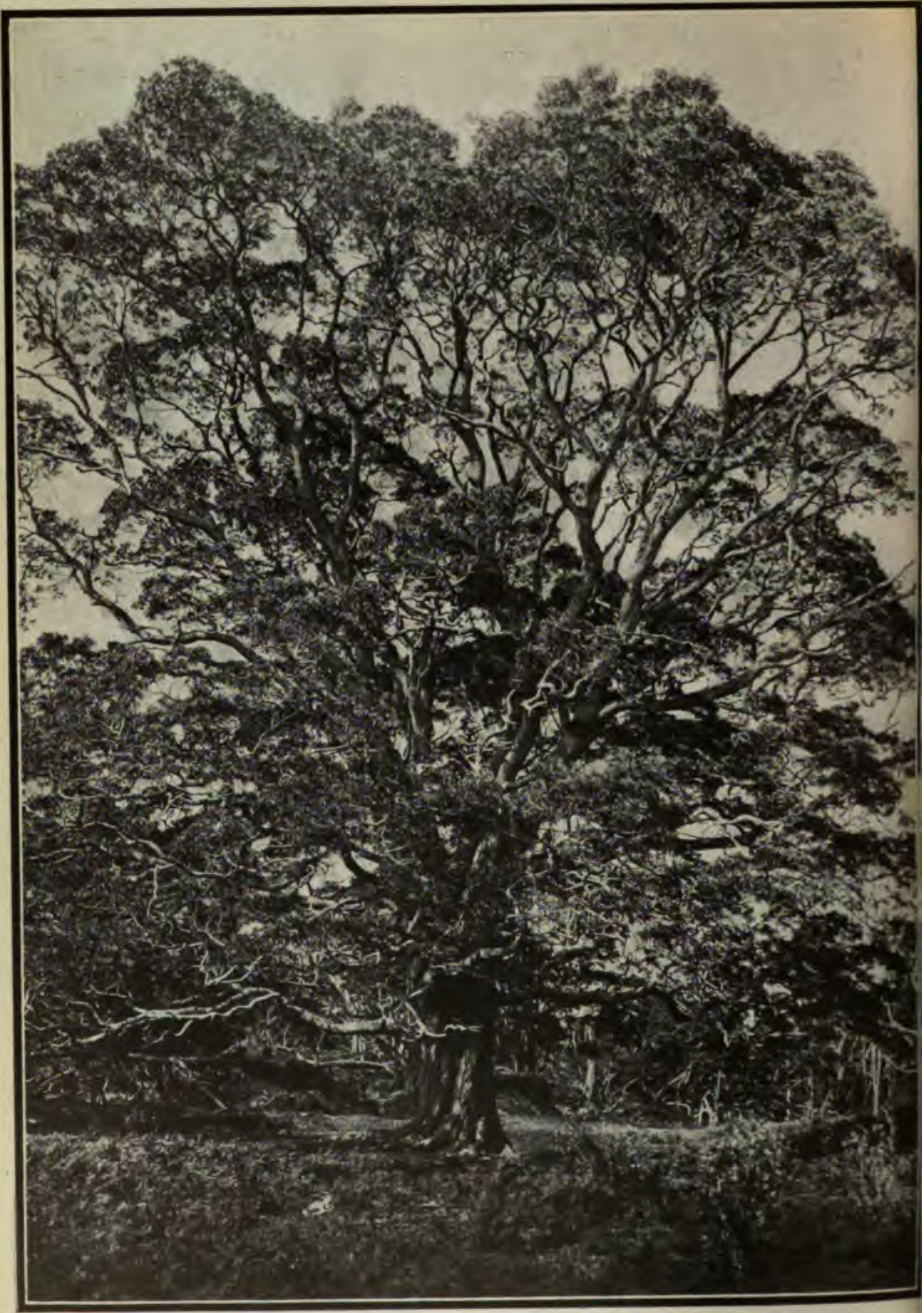

ACACIA KOA HAWAIIENSIS Rock

Koa.

Tree about 80 feet tall, with diameter of trunk about 4 feet; growing in the Kipuka Puaulu, near Volcano Kilauea, Hawaii; elevation 4000 feet.

BOTANICAL BULLETIN No. 5. JUNE, 1919

Territory of Hawaii
BOARD OF AGRICULTURE AND FORESTRY

DIVISION OF FORESTRY
C. S. JUDD, *Superintendent*

The Arborescent Indigenous Legumes of Hawaii

BY

JOSEPH F. ROCK
Consulting Botanist

ISSUED JUNE 9, 1919
HONOLULU, HAWAII

LETTER OF TRANSMITTAL.

Honolulu, Hawaii, Feb. 24, 1919.

Board of Commissioners of Agriculture and Forestry,
Honolulu, Hawaii.

Gentlemen:

I have the honor to transmit herewith the manuscript of a paper entitled "The Arborescent Indigenous Legumes of Hawaii," by Mr. Joseph F. Rock, *Consulting Botanist of the Division of Forestry* and also *Botanist of the College of Hawaii,* and to recommend that it be published as Botanical Bulletin No. 5 of the Division of Forestry.

In this paper Mr. Rock has brought together botanical information concerning the few endemic arborescent species of the family *Leguminosae* found in the Hawaiian Islands which should be of particular interest because of the fact that it includes descriptions of the well-known koa.

Very respectfully,

C. S. JUDD,
Superintendent of Forestry.

Approved:
Board of Commissioners of Agriculture and Forestry,
February 27, 1919.

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PREFACE

The Hawaiian Islands are very poor in arborescent *Leguminosae*; in fact, the whole family is very sparingly represented in comparison to families like *Rubiaceae, Rutaceae, Campanulaceae* tribe *Lobelioideae*.

Of truly endemic species other than arborescent ones the Islands possess only four, viz: *Canavalia galeata* Gaud. and a variety *pubescens, Vigna sandwicensis, Vigna oahuensis* and *Vicia Menziesii*; the last named has only been collected by early collectors such as Menzies, Macrae and Remy.

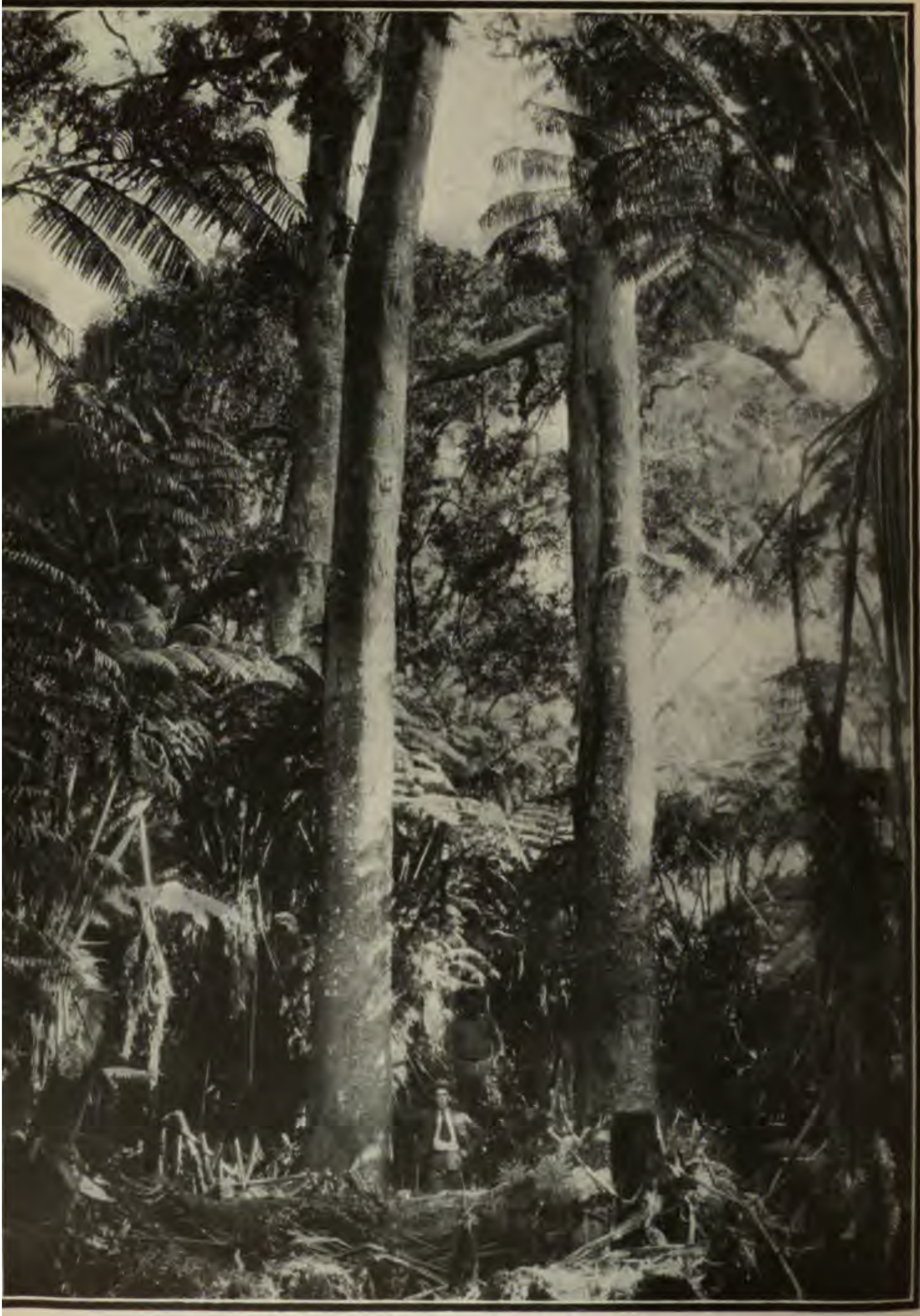
Of indigenous species found elsewhere we find twelve. A large number of species of *Leguminosae* have, however, been introducd and amount to about two hundred. Most of our introduced ornamental trees belong to this family.

THE GENUS *ACACIA*

Before discussing the three endemic Hawaiian species of *Acacia,* it may be worth while to consider the genus as a whole, at least its distribution. The name *Acacia* is of doubtful origin, but presumably has been taken from the word *akazo,* "I sharpen," in reference to the sharp spines with which many *Acacias* are fitted out, especially the African species, though a number of Asiatic species possess them also. Spines are, however, not characteristic of the Australian species, nor of any of those found elsewhere in the oceanic islands, as, for example, Hawaii, Fiji, Samoa, Tonga, and the New Hebridean group.

The genus *Acacia* is distributed over the warmer regions of the globe, but is particularly numerous in Africa and Australia. There have been described about 500 species or perhaps even more. The definite number cannot be given with any degree of certainty, as new ones are being continually discovered by botanists. The remarkable fact remains, however, that of the approximate five hundred species, more than three hundred are purely Australian. Of all these numerous species found in Australia, only a single one, *Acacia Farnesiana,* is not endemic; the rest are peculiar to that continent. Again, the largest number of the Australian *Acacias* belong to the *phyllodineous* series, while only about twenty of the three hundred species have bi-pinnate leaves. The *phyllodineous* tribe, that is species with *phyllodia* (dilated leafstalks) instead of true leaves, are almost all Australian with the exception of a very few species found in the Pacific islands such as Hawaii, New Caledonia, Mascarene and others. These cannot be identified with any of the Australian species, but, nevertheless, they do come close to some of the tropical Australian species, as, for example, *Acacia melanoxylon* to *Acacia Koa.*

Tropical Africa possesses in the neighborhood of about fifty species, all with true leaves, so that they do not concern us here. There is, however, no doubt that the *Bipinnatae* (or *Acacias* with true leaves) are the more primitive of the *Acacias.* Xerophytic regions are responsible for the reduction of true leaves to *phyl-*



ACACIA KOA HAWAIIENSIS Rock
Koa.
Showing straight growth of bole in wet or fern forest, near Volcano Kilauea, Hawaii; elevation 4000 feet.

lodia, as can be seen in certain bipinnately-leaved Australian species, where the leaflets of the pinnae have been reduced to a minimum, and where even the possibility exists to shed these leaflets in case of severe drought when their presence is either not necessary or dangerous to the plant. In no species of *Acacia* with typical bipinnate leaves has the occasional development of *phyllodia* been observed. The reverse has been of frequent occurrence. A number of *Phyllodineae* are known which revert back to bipinnate leaves, especially when they occur in situations with great humidity and where shade is prevalent. Bipinnate leaves will be found especially near the ground because of the proximity of humidity and shade condition, and also perhaps on account of their being primitive leaves. *Acacia Koa* in its young state, for example, especially when occurring in the rain forest, possesses bipinnate leaves only. Twigs with bipinnate leaves are occasionally found sprouting from the main trunks of large trees, especially after the winter rains.

The more primitive of the Australian *Acacias* are in all probability those with a globose (capitate) inflorescence, to which type the Hawaiian species belong. The *phyllodium* in *Acacia* is undoubtedly due to climatic conditions, and especially to light conditions. The drier and brighter the locality, the less foliage is usually developed and consequently the trees become open and shadeless. Wherever *Acacia Koa* grows in the rain forests of Oahu it forms dense globose crowns with a maximum amount of foliage, while *Acacia Koa hawaiiensis* in the upland of Hawaii produces large *phyllodes,* but the crowns are open and the foliage is scanty. Whether the described characteristics of *Acacia Koa hawaiiensis* are due to location or are inherent is difficult to state. The tendency to the development of broad phyllodes seems to be due to high altitude and consequent fog and mist. This has been illustrated in plants of *Acacia Koa hawaiiensis* grown from seed in San Francisco, California, whence Mr. W. M. Giffard brought the writer specimens of *phyllodia* of such width as have so far not been observed in any Hawaiian-grown plant. The narrow-leaved forms of the Oahu *Koa*, the true *Acacia Koa,* are due evidently to lower altitude and consequent absence of fog. The narrow *phyllode* is developed in greater number, resulting in a densely foliate crown.

The factors responsible for these types of *phyllodes* have, then, been light, warmth, humidity and soil. We must, however, look upon the *phyllodineous* character of *Acacia Koa,* not as evolved in Hawaii, but in its ancestor or ancestors on Australian soil. This character became modified by Hawaiian climatic conditions, which produced what we now recognize as *Acacia Koa,* its varieties, and *Acacia Koaia* and *Acacia Kauaiensis.*

Acacia melanoxylon R. Br. comes near *Acacia Koa hawaiiensis* especially in the vegetative organs if not reproductive organs, and fruit. The *phyllodes* of *A. melanoxylon* R. Br. or the Blackwood of Australia are much closer to the variety *hawaiiensis* of *Acacia Koa* than the true *Acacia Koa* of Oahu. Both have the broad, obtuse, almost straight phyllodes, the main difference being in the pod, which is narrow and more or less twisted in the blackwood and broad and straight in *Acacia Koa* and its varieties. The habits of the two species seem to be the same as the following extracts from Dr. J. H. Maiden's "The Forest Flora of New South Wales," and the illustrations of *Acacia Koa hawaiiensis* will corroborate. To quote:

> "As far as southern New South Wales and Gippsland are concerned, the blackwood must be considered as a mountain species, though it occurs occasionally in the low coast land; but there it never attains any size. It varies a good deal in mode of growth, according to situation and geological formation. In the rich humus of the jungle of the mountain slopes, it attains a height of from 60 to 80 feet, and in Gippsland, along the boundary of New South Wales and Victoria, localities may be found where it attains a height of one hundred and twenty feet, and a diameter of nearly three feet. Their straight trunks may be seen without a limb, from sixty to eighty feet, the timber quite sound and possessing that beautiful dark color whence the species has derived its popular as well as its scientific name. When it grows on high mountains * * * amongst rocks and precipices it grows very gnarled and spreading, from twenty to forty feet high and from one to two feet in diameter, sending out thick, long, gnarled and crooked limbs quite close to the ground."

Any one who has seen *Acacia Koa hawaiiensis* on Hawaii in various stations such as humid rain forests and open lava flows, could hardly describe its habits otherwise than has been done by Dr. Maiden, in the article quoted on *Acacia melanoxylon.* The plates here introduced illustrate well these different habits.

THE GENUS *ACACIA* IN THE PACIFIC.

The number of *Acacias* in the Pacific islands is quite small, in comparison to the enormous number found on the continent of Australia. Those known are *Acacia spirorbis,* found in New Caledonia and the Isle of Pine, and *Acacia fulgens,* as well as *Acacia granulosa,* peculiar to New Caledonia.

Acacia laurifolia is one of the widest distributed species, being found in New Caledonia, Tahiti, Samoa, Tonga, and Viti Islands, as well as in the New Hebrides. *Acacia Richii* is peculiar to the Fiji Islands, where it occurs on Vanualevu and Naloa. In New Guinea a few species have been discovered, as *Acacia Simsii* in Dutch New Guinea, also *Acacia glaucescence.* Mr. Merrill described a *phyllodineous* species (*Acacia confusa*) from the Philippines, the only one of that type known from that archipelago. To us the most interesting of all *Acacias* is *Acacia heterophylla* of Mauritius and Bourbon of the Mascarene group in the Indian Ocean, thousands of miles distant from Hawaii, with which our *Acacia Koa* is almost identical. It certainly is most peculiar to find two plants practically not at all distinct from each other in two so extremely remote geographical stations as Mauritius, in the Indian Ocean, in the southern hemisphere, and Hawaii, in the north Pacific Ocean. New Zealand, in such proximity to the source of *Acacia,* at least to the *phyllodinous* species, has not a single indigenous *Acacia.*

The Hawaiian Islands possess three species of *phyllodineous Acacias* and two varieties of one species. The island of Kauai, by far the oldest of the group, possesses a species (*Acacia Kauaiensis* Hillebr.) which is peculiar to it. *Acacia Koa* is, however, not absent. The former species seems to be restricted to the western part of the island. The typical *Acacia Koa* occurs all over Oahu, in one locality on Molokai, and is more or less distributed on Maui. On the island of Hawaii it is represented by a variety, *hawaiiensis,* while on Lanai another variety, *lanaiensis,* represents it. *Acacia Koaia* Hillebr. is found on Molokai, Maui and Hawaii in dry situations.

Next to ohia lehua (*Metrosideros collina polymorpha*), *Acacia Koa* is one of the most common forest trees. It occupies the zone from 1000-4000 feet elevation, but in some instances ascends to 7000 feet elevation, as, for example, var. *hawaiiensis* on Hawaii. The presence of *Acacias* in Hawaii must be attributed to birds, as the seeds of *Acacias* are not particularly adapted for dispersal by ocean currents. Yet the birds to which we could attribute this introduction, or rather which could be responsible for its presence in Hawaii, do not exist today, but were in all probability the now extinct *columbae* and their relatives. The thought of human agency must altogether be excluded when we examine the fauna to which *Acacia Koa* is host. The writer can only quote Dr. Perkins' able words:

"In judging the length of time that any particular plant or group of allied plants has existed in the islands, the botanist would be well advised to consider the fauna that is specially attached to these. When one considers that trees little modified from foreign species, e. g., *Acacia Koa* or *Sophora chrysophylla,* possess a great endemic fauna, not only species, but even genera of birds and insects, quite restricted to or dependent on them, and that some of these creatures are certainly themselves not less remarkable in their peculiarities than the most peculiar of the Composites or Lobelias, we may hesitate to attribute such plants to a later era than many other elements of the flora, which at first sight appear far more ancient."*

In following up Dr. Perkins' statement we find, however, that he had not so much *Acacia Koa* in mind as the *Compositae* and *Lobelioideae,* which, indeed, especially the latter, have peculiar birds dependent on them more or less for their existence. Dr. Perkins seems to class *Sophora chrysophylla* as an *Acacia.* To quote: "As with *Clytarlus,* the two native acacias, *Acacia Koa* and *Sophora chrysophylla,* are favorite foods of *Plagithmysus,* for six species are found on the former and three on the latter tree."‡

This would account for his remark that the Hawaiian *Acacias* have endemic genera peculiar to them. It is true that of fourteen species of the genus *Clytarlus,* all but one are peculiar to *Acacia Koa* and the single remaining one to *Sophora chrysophylla.*†

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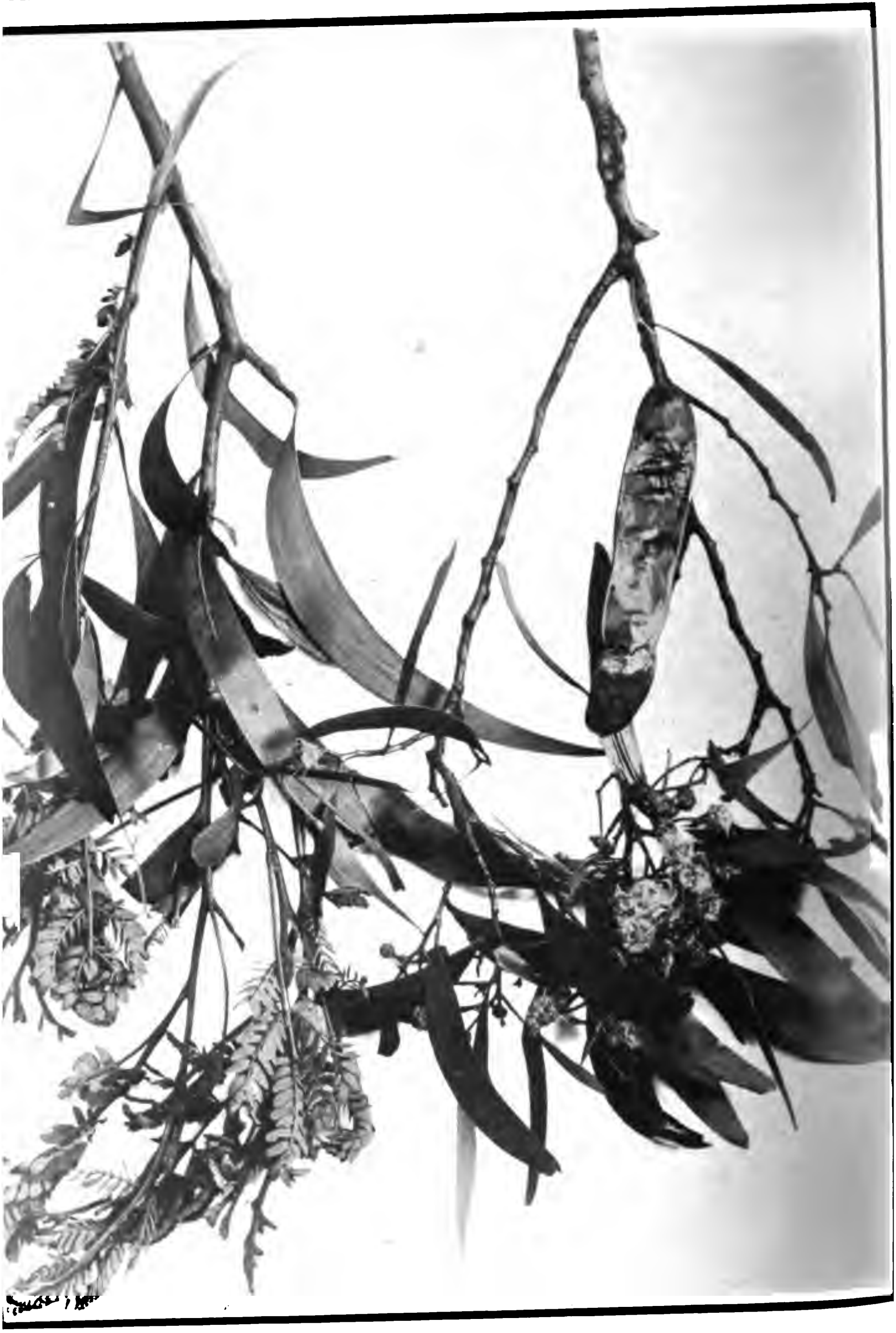
* Fauna Hawaiiensis, Introduction, Vol. I, part VI, page 60.

‡ ibid, page 117.

† For this information the writer is indebted to Mr. O. H. Swezey of the Hawaiian Sugar Planters' Experiment Station.

Perkins states that the remarkable bird *Pseudonestor* is continuously hunting for the larva of *Clytarlus* and those of *Plagithmysus,* and its stomach is often entirely filled with this food. All these facts tend to show that *Acacia Koa, A. Koaia* and *A. Kauaiensis* are old denizens and not recent arrivals, as must be assumed of *Metrosideros collina polymorpha,* the rival of *Acacia Koa.* Man, as the agent responsible for the presence of *Acacia* in Hawaii, must be absolutely excluded. For long before man in Hawaii, were the birds and native insects, and long before them the plants on which they are dependent for their subsistence.

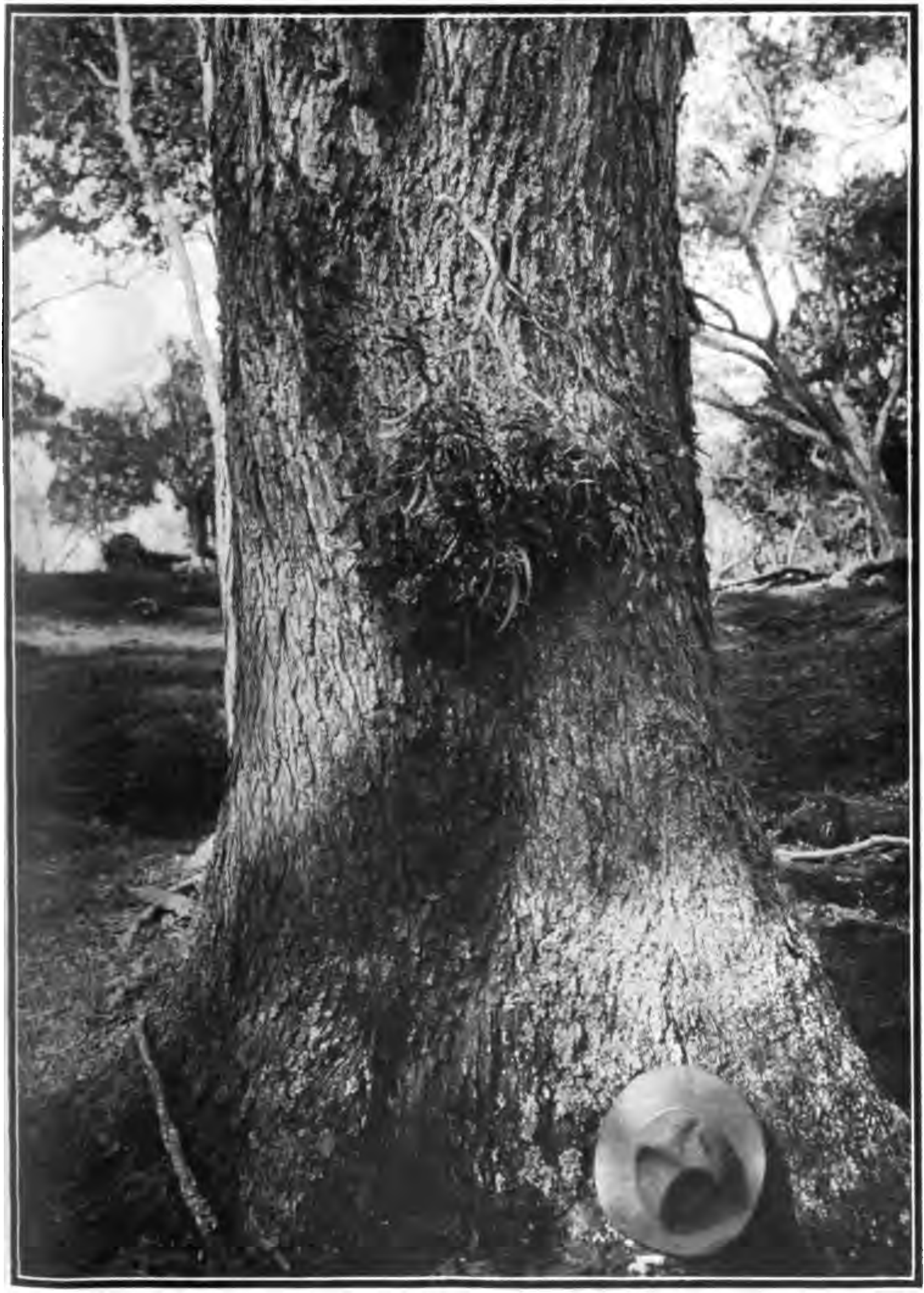
The wood of the koa is a handsome brown, varying from very dark shades to a lustrous gold, often with a handsome grain, and is much prized for cabinet work. The large trunks supplied the Hawaiians with material for their dug-out canoes, and the bark was formerly used for tanning.



ACACIA KOA Gray
Koa.

About one-third natural size. Showing true leaves and phyllodia, flowers and fruits.

PLATE IV.



ACACIA KOA HAWAIIENSIS Rock
Koa.
Showing trunk, bark and flowering branch; near tree-molds, Kilauea, Hawaii; elevation 4000 feet.

Acacia Koa Asa Gray, Bot. U. S. Expl. Exped. 480. 1854.
Acacia heterophylla Hook. et Arn., Voy. Bot. Beech. 81. 1832.

Phyllodia falcate, coriaceous, 10-15 cm. long, varying from 6-8 mm. to 24 mm. or more in breadth, narrowed at the base, acute or obtuse at the tapering apex; the smooth surface is striate with many nerves, leaves on young plants bipinnate, each pinna consisting of 12-15 pairs of oblong emarginate, crowded leaflets; peduncles solitary or fascicled in the axils, about 12 mm. long, bearing a dense many-flowered head 8 mm. in diameter; calyx teeth very short; petals 5, oblong lanceolate, glabrous, more or less united, longer than the calyx, half the length of the stamens; legume broadly linear, straight or slightly falcate, 7.5-15 cm. long, 16-18 mm. broad, glabrous, flat, about 12 seeded, seeds flat, dark brown to black.

Acacia heterophylla Willd., with which *Acacia Koa* was first identified by Gaudichaud, who had seen both the Hawaiian plants and those of the island of Bourbon (Mauritius) growing in their respective native countries, differs from the Hawaiian *A. Koa* established by A. Gray very little, indeed, if at all. The writer has an authentic flowering specimen of *Acacia heterophylla* Willd. before him, from the Royal Gardens, Pamplemousses, Mauritius; the flowers which the writer examined of the last mentioned species differ very little from those of *Acacia Koa*; the sepals and petals in the Hawaiian plant are shortly dentiform, and like the petals united; the former are somewhat more deeply cut or in other words a little more lobed than in *A. heterophylla*. In the latter species the petals are slightly longer than in *Acacia Koa*. The *phyllodia* in *A. heterophylla* are much straighter, but are otherwise the same as in *A. Koa*; the leaflets are slightly shorter and broader. The difference, however, between *Acacia hetrophylla* and *Acacia Koa* is much less pronounced than that between *Acacia Koa* and *Acacia Koaia*. Asa Gray was correct in his statement: "*In distinguishing the two trees, peculiar to these most widely separated stations, perhaps I incur the charge of being influenced by geographical considerations rather than botanical characters.*"

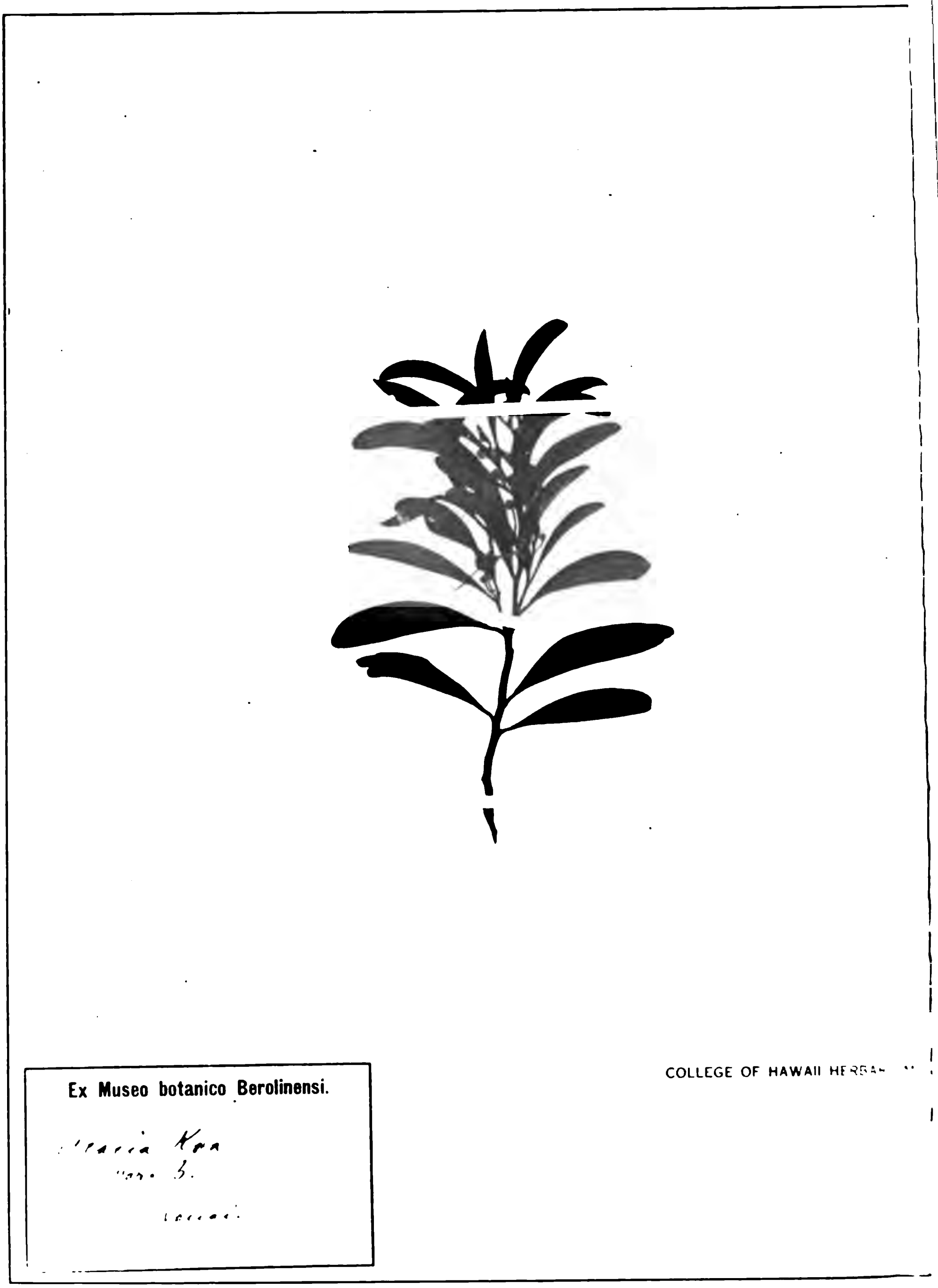
Unfortunately the specimen in the College of Hawaii Herbarium of *A. heterophylla* has no pods, but from the description in Baker's Flora of Mauritius it can be judged that they do not differ much from those of the Hawaiian trees. On Hawaii the trees of *Acacia Koa* have certainly a different aspect from those of Oahu, and broad *phyllode* specimens were named var. *latifolia* by Bentham; A. Gray states that it is only a state of the species. It is true that the *phyllodes* when young are of a different shape from the older ones, but in the Hawaii plants the mature *phyllodes* of any tree are much broader and ovate-oblong, and notwithstanding their width are shorter than or rarely as long as the Oahu specimens; they are, however, often more than twice as broad as those in the Oahu specimens. Whether the name *latifolia* was applied by Bentham to the young form of an Oahu specimen or to the typical Hawaii broad-leaved form cannot be determined now. The writer would suggest, then, for the Hawaii *koa* the varietal name *hawaiiensis,* and for Hillebrand's variety *β*, the name *lanaiensis,* since the variety has so far been found on Lanai only.

It is extremely interesting to find that in so widely separated regions as Mauritius, off the coast of Madagascar, in the southern hemisphere, and the Hawaiian Islands, in the middle of the North Pacific Ocean, there should occur two *Acacia* practically not at all differing botanically from each other. In the writer's opinion, A. Gray was not justified in establishing the Hawaiian *Acacia* as a separate species for mere geographical reasons. It may be stated that it is not taken for granted that *Acacia Koa* is derived from *Acacia heterophylla* or vice versa, but that they are an offspring from a common ancestor, the home of which was or is undoubtedly Australia, and that owing to similarity in climate and environment both have developed on common lines, notwithstanding the vast distance separating these geographical stations. The common ancestor may be looked for in relatives of *Acacia melanoxylon,* which has also connate sepals and petals, but varies mainly in the pod, which, however, comes exceedingly close to our *Acacia Koaia.*

Acacia Koa lanaiensis Rock
Acacia Koa β var. Hillebr. Flora Haw. Isl. 113. 1888.

A medium-sized tree, branching habit of the species, phyllodes 3.5-8 cm. long, 8-15 mm. wide, very little curved, almost straight, obtuse, mucronate, petiole about 4 mm., with the usual gland on the upper side; racemes very short, flowerhead and flowers as in the species; pod not seen.

PLATE V.



ACACIA KOA LANAIENSIS Rock

LANAI: Hillebrand in Herbarium Berlin and part of type in the Herbarium of the College of Hawaii;—Puu Manu, elevation 1000 feet, also Waiakeaku, the last valley of the main ridge, flowering July 29, 1910, Rock no. 8028 in herbarium College of Hawaii.

Hillebrand's specimens of this variety are much more distinct than the writer's from Waiakeaku. While short obtuse *phyllodes* occur, long acuminate ones occur also. As a whole the plant from Waiakeaku is little distinct, but Hillebrand's specimens are undoubtedly worthy of varietal rank.

Acacia Koa hawaiiensis Rock

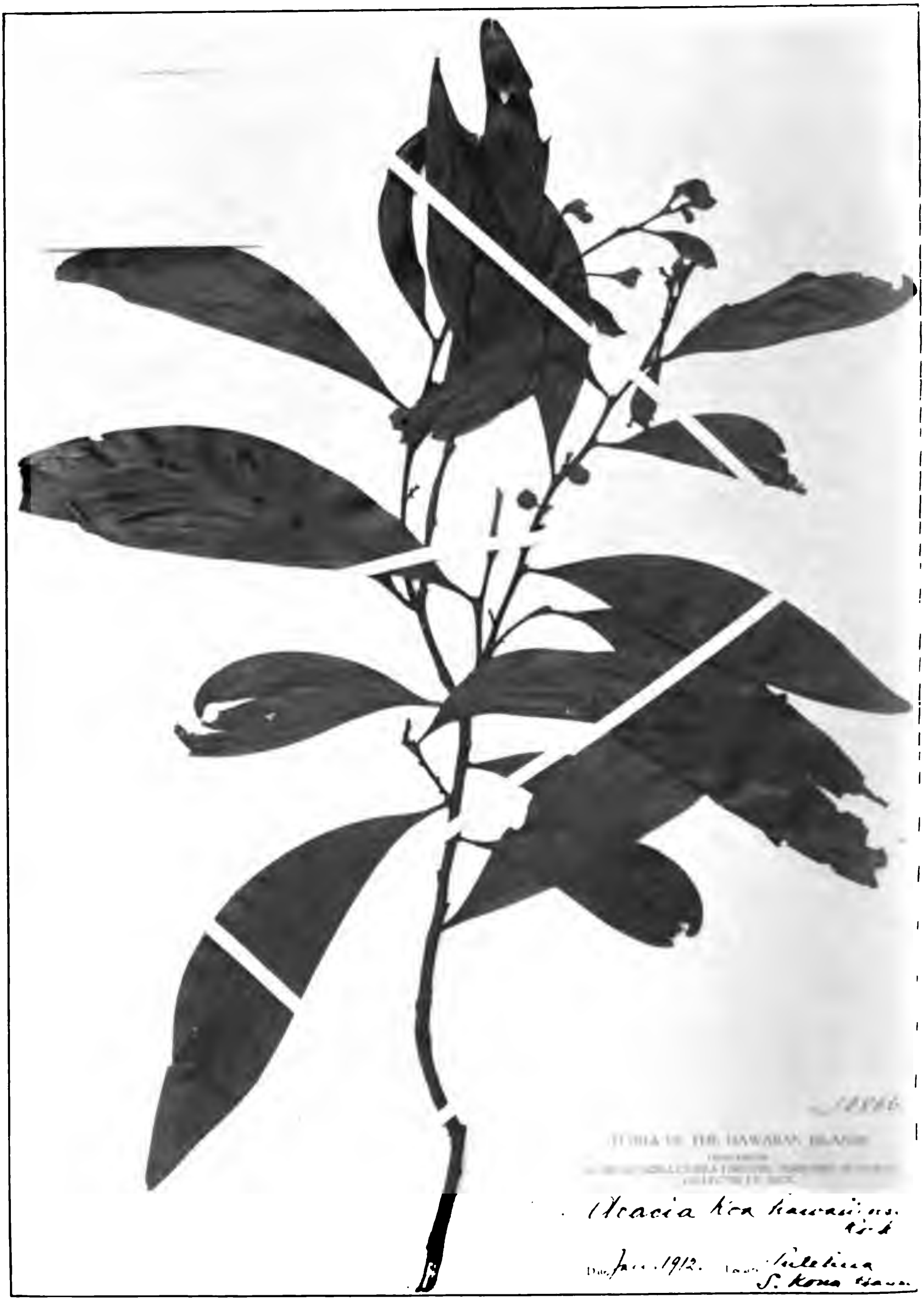
A lofty tree reaching 25-33 m., and a diameter 1.7-2 m.; branches gnarled wide spreading; glabrate when old, densely tomentose when young, with a yellowish green velvety tomentum; leaflets broadly sessile with an oblique base, narrower towards the apex, rounded, with minute mucro, glabrate on both sides, but rhachis tomentose; phyllodia broad obovate to ovate to linear-oblong, hairy when young on both surfaces, but soon glabrate, slightly curved, acute at both ends or obtuse at the apex and uncinate, many nerved (usually ten), 12.5-16 cm. long, 2.5-5 cm. wide, coriaceous, on petioles of about 5 mm., with a gland on the upper side at the base of phyllode; flowerheads single or two or three on a common peduncle of 1.5 mm., and the lateral ones, 3 mm.; heads densely flowered small; sepals one-third the length of the calyx, hirsute at the apex; stamens numerous; petals ovate, obtuse more than one-third the length of the corolla, pod about 11 cm. long, 2.5 cm. wide, flat, the suture straight or slightly wavy.

HAWAII: At the higher levels from 4000 to 6000 feet elevation;—Mt. Hualalai-Hinakapauula, fruiting June 10, 1919, Rock no. 3759;—Pulehua plains and forests, South Kona, flowering January 1912, Rock no. 12866;—Kau desert, elevation 3600 feet, July 15, 1915, Rock no. 12566—all in the College of Hawaii Herbarium.

This variety seems to be peculiar to the island of Hawaii, where it reaches very large dimensions. It can be distinguished mainly by its broad *phyllodes*, which are almost straight.

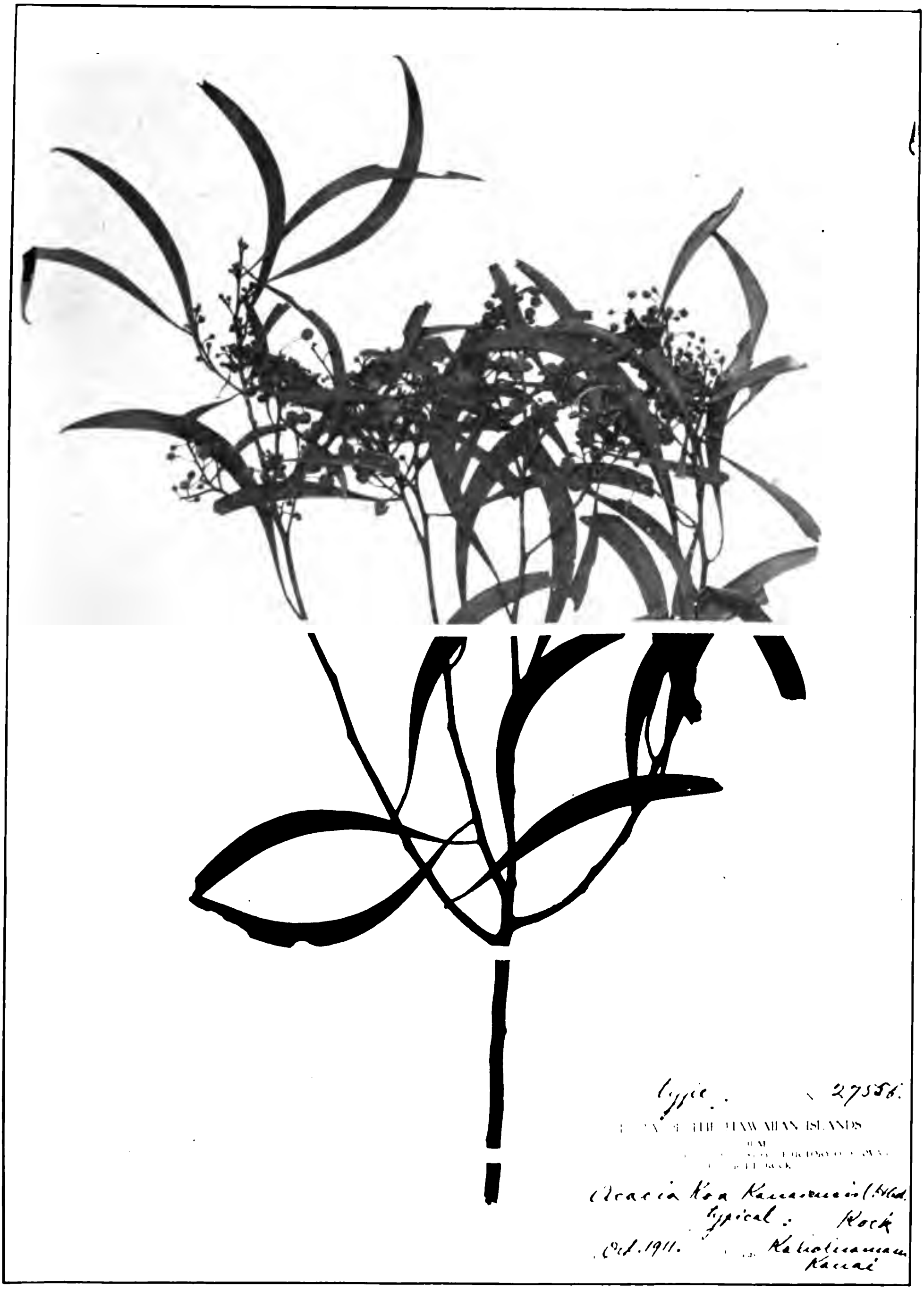
Acacia Kauaiensis Hillebr. Flora Haw. Isl. 113. 1888.

A large tree with many tortuous branches; phyllodia falciform, narrow-linear, 10-16 cm. long, about 12 mm. or less wide, with usually two or three prominent nerves, apex somewhat obtuse, mucronate-uncinate, with



ACACIA KOA HAWAIIENSIS Rock

PLATE VII.



ACACIA KAUAIENSIS Hillebr.

a pitted gland on the somewhat thickened petiole; inflorescence paniculate, terminal, foliose, or rather a paniculate raceme with phyllodia in the upper axils and below which are situated the peduncles of about 1 cm. in length, each bearing several single-headed pedicels 4-6 mm. in length, tomentose with a rusty tomentum; bracts minute; sepals 5-6, free to near the base, spathulate-obtuse, glandular pubescent as are the petals, the latter oblonceolate, one-half longer than the sepals, ovary puberulous; pod straight thick, coriaceous, 15 cm. long, 2 cm. wide, about 15 seeded, seeds as in **A. Koa.**

> KAUAI: Halemanu, Knudsen no. 55;—Halemanu, fruiting February 14-26, 1909, Rock no. 2154 in College of Hawaii Herbarium;—Kaholuamano, outskirts of the forest, flowering October 1911, Rock no. 2755-b (type);—same locality, flowering October 1916, Rock no. 12868 in the herbarium of College of Hawaii.

The apparently typical form is no. 2755 from Kaholuamano and no. 2154 from Halemanu, where V. Knudsen collected his specimens. The free sepals and petals, and the racemose-paniculate inflorescence, distinguish this variety at once from the species; otherwise it has the same habit as *A. Koa.* This rather interesting tree, which Hillebrand established as a species, distinct from *A. Koa,* has hitherto been overlooked owing to its great resemblance to *Acacia Koa.* It inhabits the dry open slopes on the leeward side of Kauai on the edge of the canyons, especially on the Halemanu side along the Waimea canyon to Milolii. At the Kaholuamano side, where there seems to be a little more rainfall, the *phyllodia* are larger and the inflorescence is not exactly paniculate, though the sepals and petals are free. The tree does not reach such dimensions as the variety *hawaiiensis* of *Acacia Koa,* the trunk being usually short and the branches a good deal twisted and sometimes reclining nearly on the ground. The *phyllodia* are long, sickle-shaped and narrow, the upper ones being uncinate. Similar to *Acacia Koa hawaiensis,* when growing in damp or wet mixed forests in company with other trees, it develops a tall straight bole some forty feet without branches, after which the crown commences. Beyond the Kopiwai forest it grows in company with *Xanthoxylum dipetalum Hillebrandii* Rock (*X. dipetalum* var. γ Hillebr.), *Alphitonia excelsa, Antidesma platyphyllum, Pelea Kauaiensis, Santalum pyrularium,* and others.

Acacia Koaia Hillebr. Flora Haw. Isl. 113. 1888.

A small gnarled tree, wood hard, close grained; branches terete, true leaves not seen; phyllodia coriaceous, falcate, linear, narrow, acute at the apex, acuminate at the base, with three prominent nerves, 6-12 cm. long, 8-10 mm. broad, the apex with a recurved mucro; petiole about 5 mm., with a thickened gland on the convex side of the petiole or rather base of the phyllode; racemes axillary with not more than three heads, generally reduced to a single one; flowers as in **Acacia Koa**; pod very narrow, 8-10 mm. in width, 10-15 cm. long, somewhat curved, not of even width, but with slight constriction between the seeds; seeds oblong, the long diameter (6 mm.) in the direction of the valves, flattened, with a funis of about the same length.

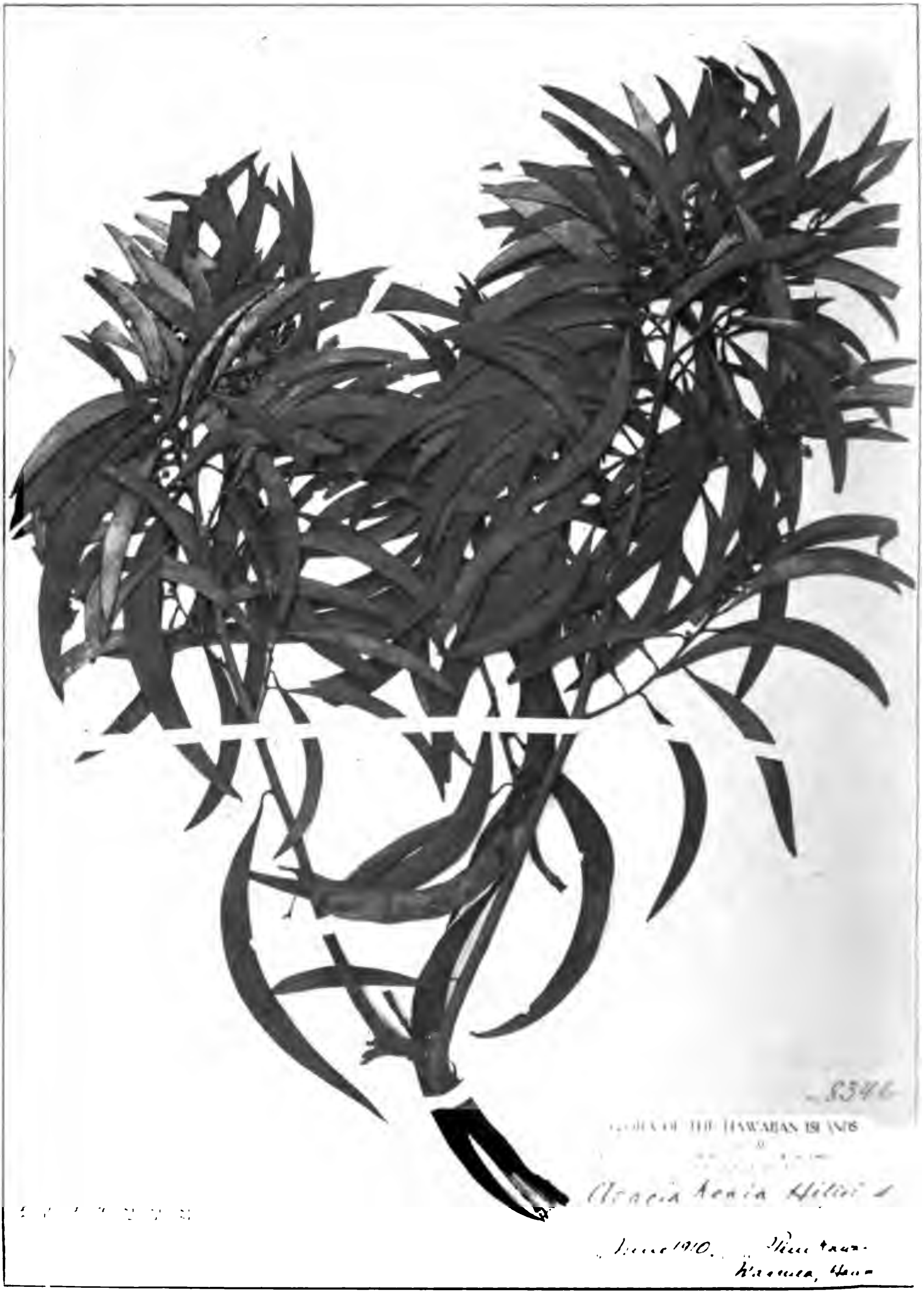
MOLOKAI: Kalae, Hillebrand in Herbarium Berlin and in the College of Hawaii Herbarium;—ridge above Kaunakakai and Kauluwai, March 1910, Rock in College of Hawaii Herbarium.

MAUI: E. Maui, Kula? Hillebrand.

HAWAII: Puukawai, Kawaihaeiuka, elevation 2000 feet, near Waimea, flowering and fruiting June 1910, Rock no. 8346 in the College of Hawaii Herbarium;—observed back of Puuanahulu, near Puuwaawaa boundary, on rough ancient aa lava flows.

Acacia Koaia Hillebr. differs from *Acacia Koa* A. Gray mainly in the pods, which are very narrow and somewhat curved. Also in the *phyllodes*, which are narrow linear and less curved. *Acacia Koaia* or *Koaie*, as the natives call this species, and which name was adopted by Hillebrand as the specific name, has a rather restricted distribution. It seems to be the older of the two species occurring in these islands. So far as known, it is absent from Kauai, Oahu and Lanai, also Niihau and Kahoolawe. On the three remaining islands it occurs only sparingly. On Molokai the writer collected it at Mapulo-u immediately below Kamoku on the dry exposed ridges leading towards the dry stony slopes of the Kaunakakai-Kauluwai district. It is a small bushy tree on the crest and protected declivities of a ridge, where it grows in company with *Myoporum sandwicense*, *Nothocestrum latifolium*, *Sideroxylon molokaiense* Rock (*S. spathulatum molokaiense*) and a species of *Lipochaeta* (*Nehe*). On the same island it was collected by Hillebrand at Kalae. On Maui it was collected by Hillebrand only on the lee slopes of Haleakala at

PLATE VIII.



ACACIA KOAIA Hillebr.

Kula. The Kula region is now almost barren and waste, save for a few *Dracaena aurea* (*Halapepe*) trees which were in existence a few years ago.

Until 1909 *Koaia* had not been recorded from the island of Hawaii. The writer discovered it on the upper slopes of Kawaihae in the neighborhood of the extinct crater Puukawai along the road leading to Waimea. Quite a number of trees were then in existence. It was also quite common on the Puuanahulu side of Puuwaawaa, where it grew in company with tall *Osteomeles anthyllidifolia* (*Ulei*) bushes. As it occurs in the very arid rocky regions, it is doomed to extinction, for such regions on Hawaii have been given over to cattle and sheep grazing; young plants which would perhaps germinate after southerly rains are eagerly devoured by both cattle and sheep. Owing to the causes just mentioned, *Koaia* has already disappeared from Maui. On Molokai a similar fate awaits it if it has not already been exterminated by roaming horses, cattle and sheep.

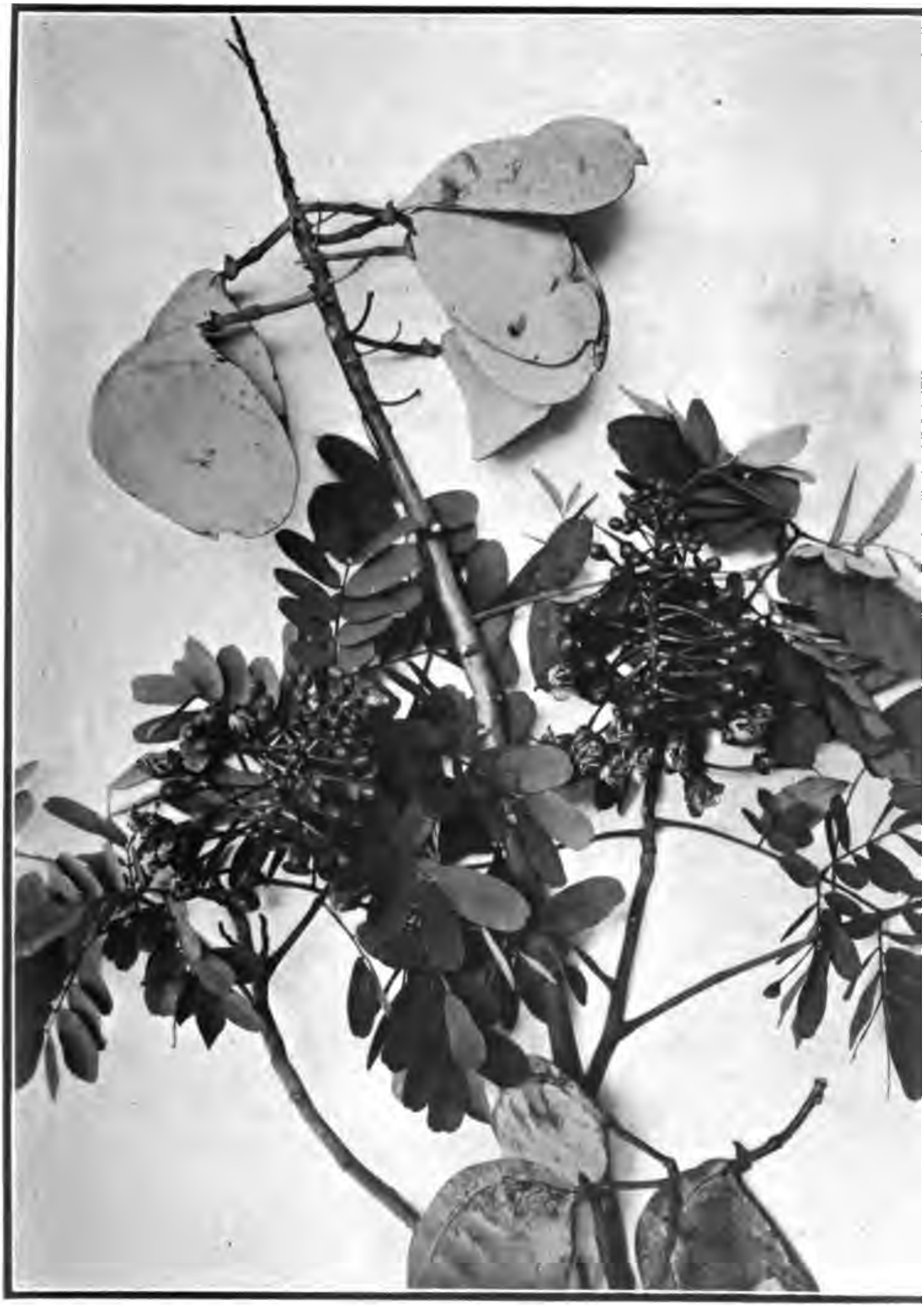
Acacia Koaia is easily distinguished from *koa* in the more rigid phyllodes and narrow, curved pods. It can be recognized even from a distance by its shape; its stature is much smaller than that of *Acacia Koa,* reaching rarely more than 25 feet. The trunk is usually gnarled and twisted. On Hawaii it associates with *Nothocestrum breviflorum, Sophora chrysophylla, Myoporum sandwicense, Nototrichium sandwicense* and *Dracaena aurea.* It is strictly a subxerophytic plant, inhabiting only the more arid lava regions or volcanic tufa soils such as predominate on Puukawai, Hawaii. It is never found on the newer lava flows as is, for example, the *Acacia Koa,* but in older geological regions. The Waimea side of Hawaii known as the Kohala mountains are extremely old and were evidently once a separate island from Hawaii. *Koaia* does not occur on the younger portion of Hawaii save near Puuanahulu, a place not distant and adjoining Kawaihaeiuka. It is probable that ages back it occurred only on the Kohala range and that it spread afterwards towards the plains and north Kona. Unfortunately, we know very little of the plant-covering which must have existed on the vast plains between Waimea and Mauna Kea. Evidences are still visible of former forests, but so meager are they that it is impossible to draw conclusions. Mamani (*Sophora chryso-*

phylla) forests must have extended considerably over this plain, as the upper part of that region would indicate by the scattered trees around Punohu and Makahalau. Kawaihae-uka, judging from Hillebrand's reports, must have supported a similar vegetation, as does Puuwaawaa today, and *Acacia Koaia* may have been quite numerous there. Another factor influencing the (restricted) distribution of *Koaia* is undoubtedly the adaptability of the species to lower levels only, while *Koa* has been observed up to 7000 feet. *Koaia* does never ascend higher than 2500 feet, consequently the arid regions at such altitudes suitable to its existence are rather limited, while *Koa*, with its wonderful adaptability, which can be compared with that of *Metrosideros*, has a very wide distribution in these Islands and can be found from practically sea level to 7000 feet, in most varied stations, as to soils, and lava flows.

MEZONEURUM Desf.

The genus *Mezoneurum* is represented in the Hawaiian Islands by a single arborescent species originally discovered by H. Mann on the island of Kauai, hence the specific name *Kauaiense*. The species had undoubtedly a much wider distribution in this archipelago. It is found on Maui and Oahu (according to Hillebrand) and also on the island of Hawaii in the dry forests of North Kona, where it was found by both Guppy and the writer. That the tree was much more common in the days of the old chiefs than now can be judged by the great many tapa beaters (made of the exceedingly hard wood of this species) which can be found in the Bishop Museum and private collections all over the Islands. Undoubtedly, the usefulness of the wood of this tree, which was very highly prized by the natives, not only for tapa beaters, but also for the *laau melomelo*, a club-shaped piece of *Mezoneurum* wood employed in a peculiar method of fishing, is responsible for the scarcity of this tree nowadays, and the writer ventures to say that there are hardly two dozen trees of this species in existence.

The presence of this species in the Hawaiian Islands is certainly a riddle for the student of plant dispersal, especially as *Mezoneurum Kauaiense* belongs to a genus of which no littoral



MEZONEURUM KAUAIENSE (Mann) Hillebr.
Uhiuhi.
Flowering and fruiting specimen. About one-third natural size.

species is so far known, from which the Hawaiian one could have been derived. The seeds of this species are quite large, about an inch long, little more than half an inch wide, and are enclosed in a very papery thin pinkish-white pod winged at the upper margin. The seeds, like those of *Erythrina monosperma,* are not buoyant, and as the genus *Mezoneurum* possesses no littoral species from which it could have been derived, we must look for other agents than ocean currents as responsible for its presence in Hawaii. The Hawaiian species is endemic, which is not the case with *Erythrina monosperma,* as the latter is also found in Tahiti and New Caledonia.

Since we cannot look upon its presence here in these Islands as due to ocean currents, we can only take bird agency into consideration, and if a bird was capable of carrying such a large seed as that of *Mezoneurum Kauaiense* across a wide expanse of ocean, then surely it was also capable of carrying the much smaller seeds of wiliwili, *Erythrina monosperma,* and thus the presence of *Mezoneurum* in Hawaii strengthens and confirms, rather than contradicts, the arguments in favor of bird agency in the case of *E. monosperma,* as set forth in the discussion of that species.

That *M. Kauaiense* belongs to an ancient floral element in these Islands rather than to a later one, there remains no doubt.

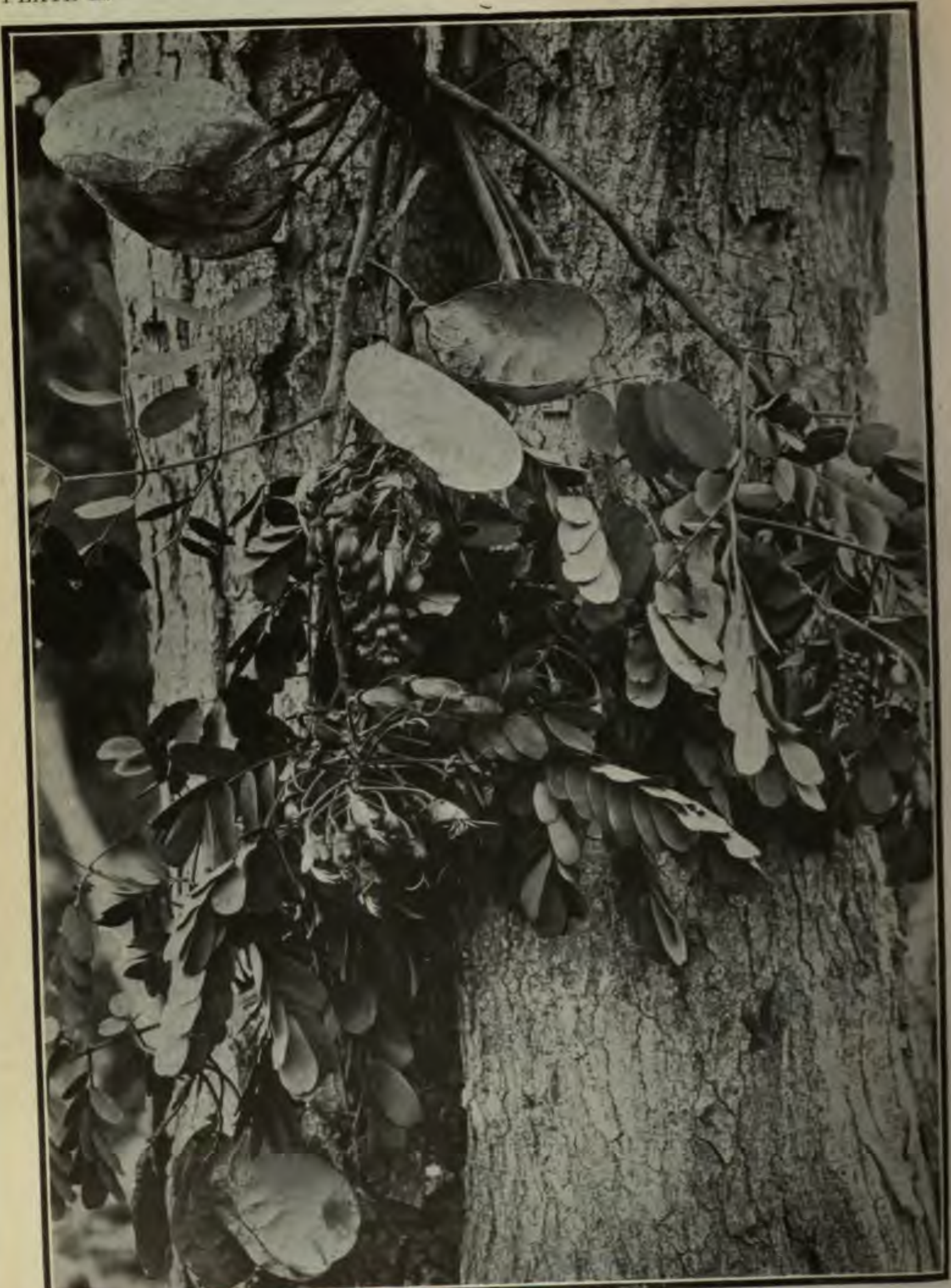
The distribution of the genus proper would also indicate it to be a rather ancient one; and although the genus numbers only about fifteen species, so far as is known today, it enjoys certainly a very wide distribution. The majority of its species are Indo-Malayan, occurring in Java, Sumatra, India, Malay, Burma, the Philippines and even China, while others are found in tropical Africa, Madagascar, Australia, and one in Hawaii. None of the other Pacific islands possesses a species belonging to this genus, and the remarkable fact remains that the species found outside of Hawaii are all strong climbers, often thorny, or scandent shrubs, while the Hawaiian species is apparently the only tree in the genus. In Hawaii the tree reaches a height of over thirty feet, with a diameter of trunk of over one foot. The relationship to other *Mezoneura* is very vague, and at present no particular country of origin could be suggested.

The relationship of *Mezoneurum* to *Caesalpinia* is very close, and as the latter genus possesses a number of littoral species, it may be that it originated from that genus; this is Guppy's theory. The writer is inclined to believe that *Mezoneurum* is older than *Caesalpinia* and that it is perhaps more probable that the littoral species have been derived from the inland species, and he would suggest that *Caesalpinia* is perhaps a satellite of *Mezoneurum*. The genus *Canavalia* in Hawaii does not help to elucidate the problem. Though of very wide distribution, it possesses both littoral and inland species. In Hawaii it is represented by an inland species, *C. galeata,* which species is represented by a variety *pubescens* on the southernmost island of this group, Hawaii. Until recently *C. galeata* was considered the only representative of this genus in Hawaii, but in 1910 the writer discovered *C. sericea,* a South Sea Island littoral species, on the eastern shore of the small island Lanai.

It is interesting to note that *C. sericea,* although a shore species, had the habit of *C. galeata.* It grew, not in the sand, but among lava rocks near old *Cordia subcordata* trees which the plant had climbed and festooned in a similar manner as *C. galeata* festoons trees at 2000 feet elevation.

The seeds of *C. galeata* are slightly smaller than those of *Mezoneurum Kauaiense,* and are also non-buoyant. *Mezoneurum* is by far the older genus as compared with *Canavalia* and *Caesalpinia,* from the mere fact that *Mezoneurum* possesses only inland species, while the other genera possess both littoral and inland species. Had the inland species of *Mezoneurum* been derived from one or various littoral species, we would probably have found somewhere a littoral species related to some or one of the inland species. The negative findings would indicate *Mezoneurum* to be older than the genera with both littoral and inland species to which it is apparently related. The arborescent character of the Hawaiian species adds still more to the difficulty of solving its origin and relationship.

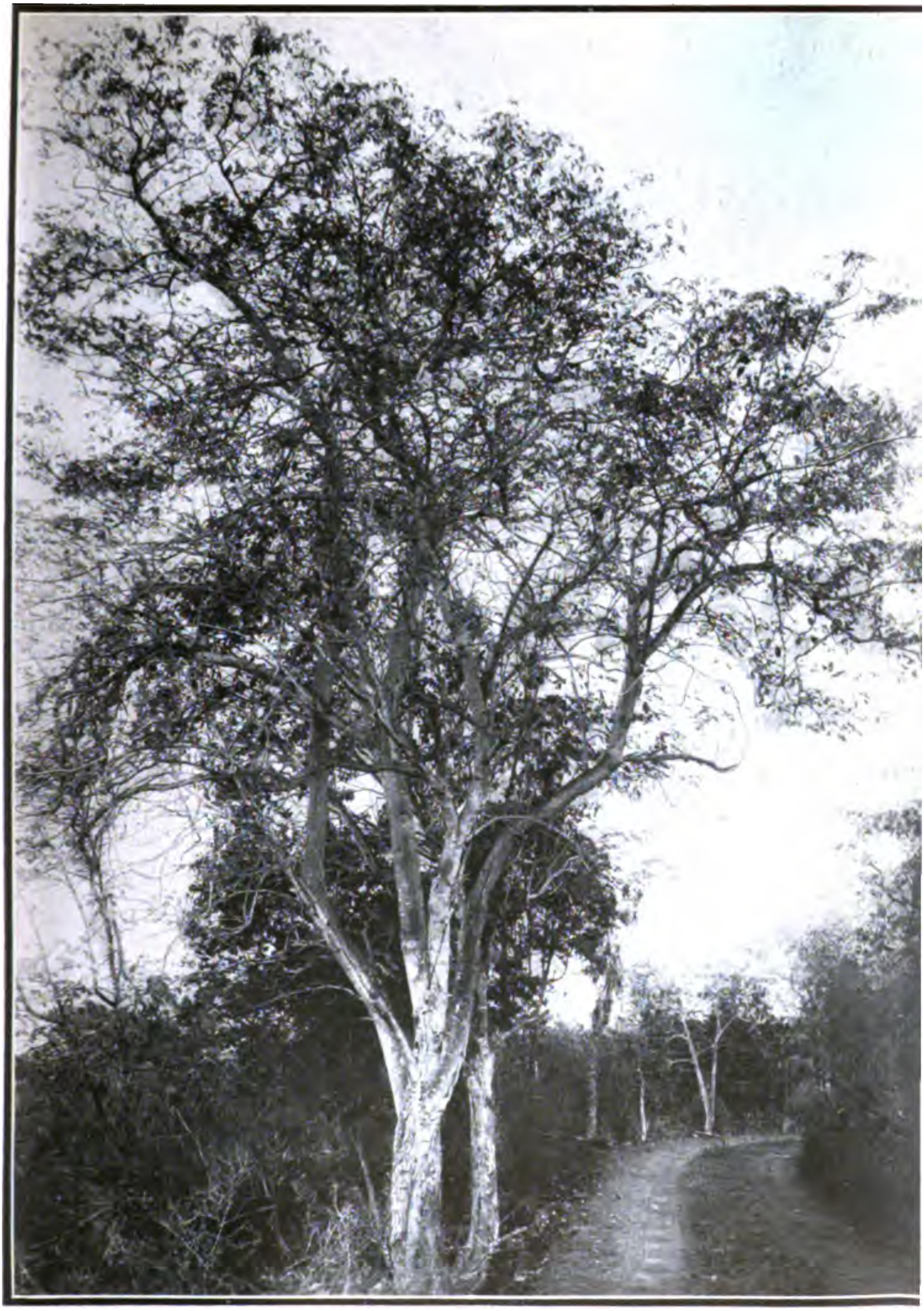
Mezoneurum seems to be more a continental genus, for Hawaii is apparently the only oceanic island on which a representative is found. Java, Sumatra, the Philippines and Madagascar are always considered islands of continental origin.



MEZONEURUM KAUAIENSE (Mann) Hillebr.

Uhiuhi.

Showing trunk with bark and flowering and fruiting branch pinned to it. Trunk about 1 foot in diameter. On lava fields of Puuwaawaa, North Kona, Hawaii; elevation 2000 feet.



MEZONEURUM KAUAIENSE (Mann) Hillebr.
Uhiuhi tree.
Along the government road in North Kona, Hawaii; elevation 2000 feet.

Mezoneurum Kauaiense (Mann) Hillebr. Fl. Haw. Isl. 110. 1888.

Caesalpinia Kauaiensis Mann in Proc. Am. Ac. VII:164. 1866.

A shrub ? or tree 10 m. in height with a diameter of trunk of 3 dm. or more; bark thick, rough dark gray, checked into rectangular or long oblong plates; branches loose, spreading, unarmed, young shoots covered with a rust to cinnamon-brown pubescence; leaves pari-pinnate, with 1-5 pairs of pinnae, each pinna with 4-8 pairs of leaflets, pinnae 4-8 cm. long; the common rhachis up to 12 cm.; leaflets oblong, somewhat unevensided at the base, emarginate at the apex up to 4 cm. long, 16 mm. wide, membranous to chartaceous, pale green with rusty-brown pubescent midrib and petiolule, the latter 2-2.5 mm.; stipules and stipellae none or small wart-like; racemes terminal hoary to rusty-brown pubescent, 12-18 cm. long with flower, 22 cm. with fruit, densely floriferous from the base; pedicels 2.5-4 cm. long, jointed in the upper fourth, bracts acute, ciliate, 4 mm., caducous; bracteoles wanting; calyx glabrous, pinkish or rose red, the short tube 4 mm., the lowest lobe concave 12-14 mm., the others oblong, obtuse about 8 mm. long, 5 mm. wide; petals pinkish purple to rose red, not or slightly stipitate, shorter than the calycine lobes, the uppermost one obcordate, folded 6-8 mm. in diameter, of deeper color (blood red especially towards the apex), the lateral ones suborbicular, the two lowest obovate, 10-12 mm. long; stamens exserted, declinate, filaments broad and flat below with reddish brown hair; anthers 2 mm., of carmine color; ovary glabrous, sessile 3-5-ovuled; style glabrous incurved; stigma small; pod broad obovate-oblong 10 cm. long, 6 cm. wide, including the 7 mm. wide dorsal wing, ending in an uncinate point, flat, thin, indehiscent pale pinkish to gray when old; seeds 2-4, transverse, pale brown, ovate flat 18-20 mm. long, 14-16 mm. wide, with a punctiform hilum at the base.

KAUAI: Hillebrand in herbarium Berlin and herbarium College of Hawaii;—Puukapele, Waimea canyon, flowering March 1909, Rock no. 2435 in herbarium College of Hawaii.

OAHU: Waianae Mts. and Wailupe, Hillebrand.

MAUI: East Maui, Ulupalakua, and West Maui, dry fore hills, Hillebrand.

HAWAII: Between Huehue and Puuwaawaa, North Kona (district of Owe), elevation 2000 feet, flowering and fruiting June 14, 1909, Rock no. 3904 in herbarium College of Hawaii;—same locality, fruiting August 1915, Rock no. 12591 in herbarium College of Hawaii.

In the Hawaii specimens the dorsal wing does not end in an uncinate point as in the Kauai specimens; at least the point is very obscure. Hillebrand records this species as a shrub, but on Hawaii it is always a tree up to thirty feet in height. The writer has collected it only on Kauai and Hawaii. In the former island it is very rare and perhaps extinct now; from Maui, Ulupalakua, it has disappeared, as the locality recorded by Hillebrand has been entirely denuded of its native vegetation.

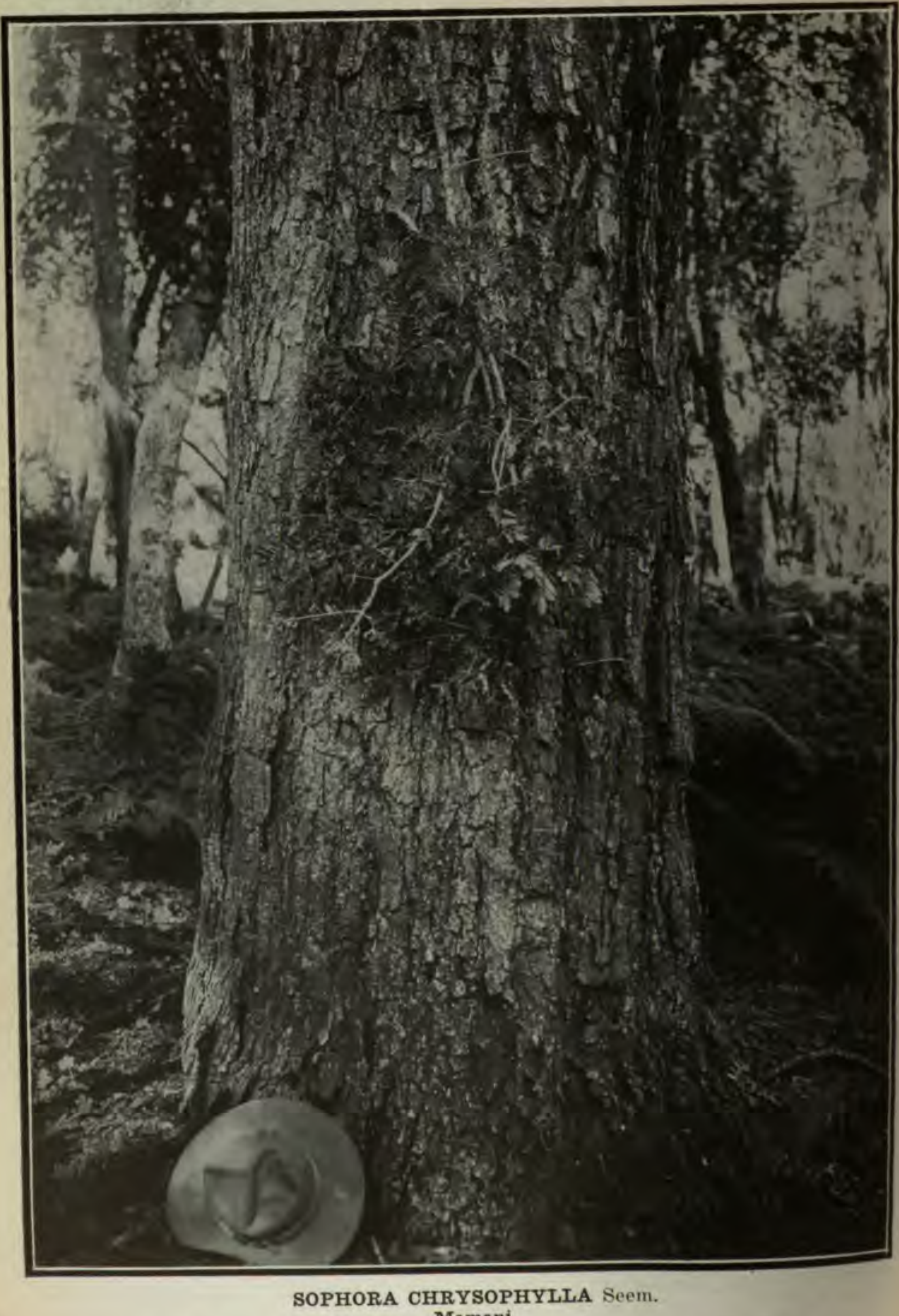
According to natives, it exists along Kaupo below the southern outlet of Haleakala crater, Maui, where the natives know it by the name *Kea*.

The wood of this species is exceedingly hard, close-grained and very durable. It is of almost black color, with a very narrow (one-quarter of an inch thick) sapwood of a light color. The natives made their spears of this wood, also a fishing implement known as *laau melomelo* or *laau makaalei*. The native name of the tree is *Uhiuhi*.

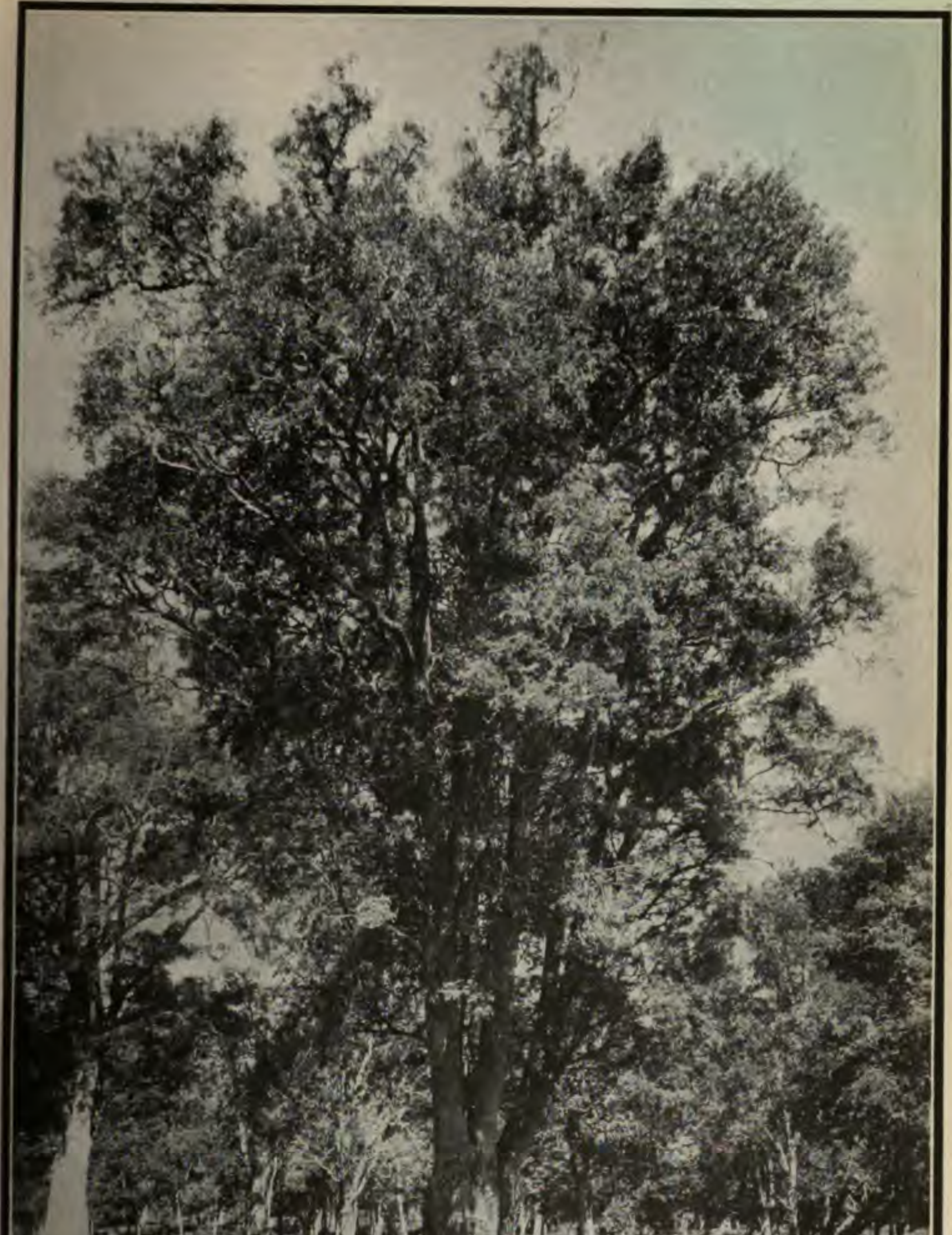
SOPHORA L.

ORIGIN OF *Sophora chrysophylla*.

That the *Mamani*, as the natives call *Sophora chrysophylla*, is an old denizen of these Islands there is little doubt. It may be of the same age as *Acacia Koa*, or may even antedate the latter. The *Mamani* belongs to the subgenus *Edwardsia*, in which we find *Sophora tetraptera, S. macrocarpa, S. microphylla, S. denudata, S. mollis* and *S. interrupta*. They are distinguished by their winged pods. In looking at the species which form this subgenus, we find that *Sophora tetraptera* occurs not only in New Zealand, but also on the Island of Juan Fernandez, Lord Howe's Island, Chatham Island, Easter Island and in Chile. *S. mollis* and *S. interrupta* occur in India, *S. macrocarpa, S. microphylla* and related species in Chili and Peru, while *S. denudata* is peculiar to Bourbon. That the Hawaiian Sophora is very closely related to *Sophora tetraptera* there is no doubt. It also occurs from sea level to 2500 feet elevation. At the lower altitudes it is a shrub, while at higher altitudes it is prostrate, while at favorable locations it becomes a tree 30-50 feet in height. *Sophora tetraptera*, the *Kowhai* of the Maoris, is very variable; a number of varieties have been described. A similar variation we meet in the Hawaiian *Mamani*. On comparing the New Zealand name "*Kowhai*" with "*Mamani*" from Hawaii we find no resemblance,

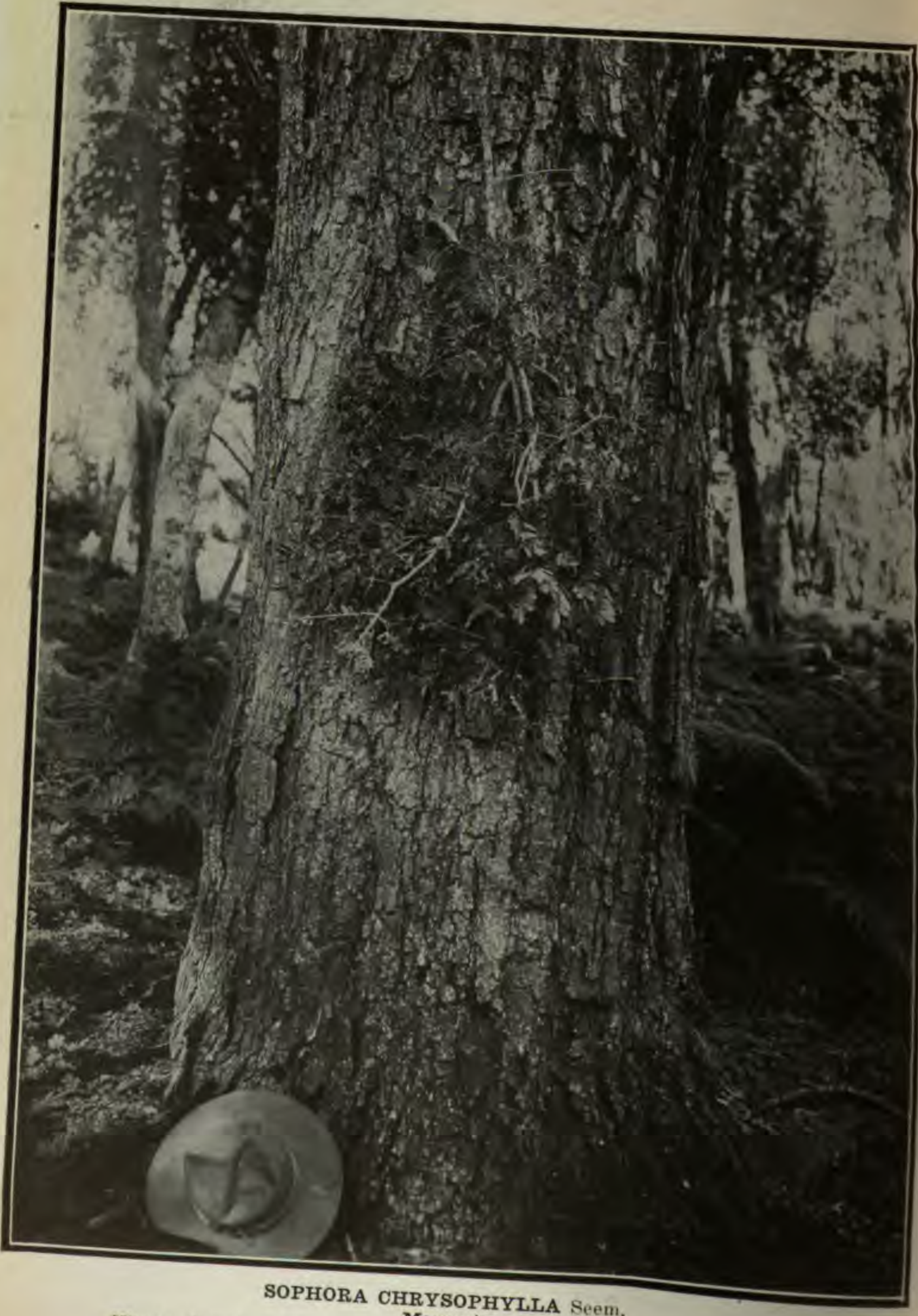


SOPHORA CHRYSOPHYLLA Seem.
Mamani.
Kipuka Puaulu, near Volcano Kilauea, Hawaii; elevation 4000 feet.



SOPHORA CHRYSOPHYLLA Seem.
Mamani.
Growing in Kipuka Puaulu, near Volcano Kilauea, Hawaii; elevation 4000 feet. Tree 35 feet high.

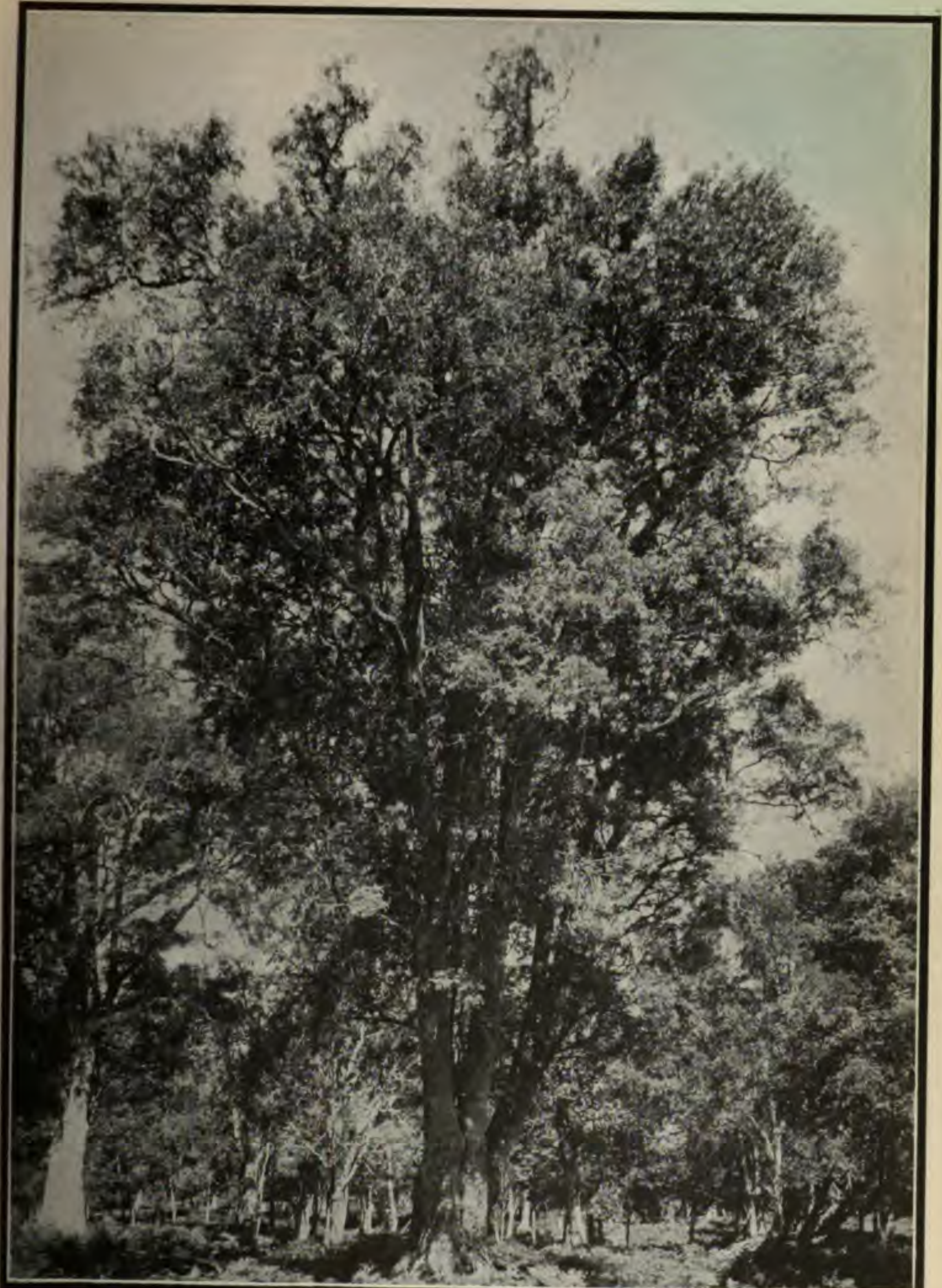
PLATE XII.



SOPHORA CHRYSOPHYLLA Seem.

Mamani.

Kipuka Puaulu, near Volcano Kilauea, Hawaii; elevation 4000 feet.



SOPHORA CHRYSOPHYLLA Seem.
Mamani.
Growing in Kipuka Puaulu, near Volcano Kilauea, Hawaii; elevation 4000 feet. Tree 35 feet high.

but on investigation we find the Hawaiian name *Ohai* used for *Sesbania tomentosa,* also a papilionaceous legume, with large red flowers, which resemble those of the *Mamani.*

The wide distribution of *Sophora tetraptera* and its occurrence in Chili would point to an American origin, rather than that it originated in New Zealand and was thence distributed to the other islands and the mainland of South America. The Hawaiian *Mamani* is in all probability of American origin and perhaps only an offspring of the ancestor of *Sophora tetraptera.* That the *Mamani* is an ancient inhabitant of Hawaii is proven by the fauna inhabiting it; we find two species of *Plagitmysus,* an endemic genus, peculiar to the *Mamani,* as well as species of *Clytarlus.* The peculiar endemic bird *Pseudonestor* feeds in turn on the larvae of these beetles, which it extracts from the wood of both the *Koa* and *Mamani.* From these facts we can see that both the *Koa* and *Mamani* must be old inhabitants and were perhaps contemporaneous in their arrival with the early *Compositae.*

Sophora chryosphylla (Salisb.) Seem. Flora Vitiensis 66. 1865.
Edwardsia chrysophylla Salisb. in Transact. Linn. Soc. IX :302, t. 26, f. 1. 1808.

Young shoots silky pubescent; leaves 15.5 to 15 cm. long, with 6 to 10 pairs of leaflets; leaflets obovate oblong, 20 to 36 mm. x 8 to 12 mm., obtuse, often retuse, with a cinerous silvery or tawny pubescence (when growing at high altitudes) or glabrous (at low elevation); racemes terminal and lateral, 12 to 25 mm. long, tomentose; calyx about 6 to 10 mm., cup-shaped lobes broad and obtuse; petals 25 mm. long, yellow, the broad vexilum recurved, the suberect alae and carina nearly as long; stamens as long as the carina; ovary tomentose; pod 10 to 15 cm. long, 8 mm. wide, often deeply constricted between the seeds, four-winged; indehiscent; seeds 4 to 8, oval, somewhat compressed, yellow, 8 mm. long.

OAHU: Waianae Mts., Keaau, elevation 950 feet, flowering and fruiting January 23, 1919, Charles S. Judd, specimens in College of Hawaii Herbarium.

KAUAI: Knudsen in Herbarium Hillebrand (Herbarium Berlin).

MAUI: Slopes of Haleakala, flowering April 26, 1909, R. S. Hosmer no. 2624 in the herbarium of the College of Hawaii;—Haleakala upper slopes, flowering May 1911, Rock in herbarium College of Hawaii.

HAWAII: Hualalai upper slopes, elevation 7000 feet, flowering June 9, 1909, Rock no. 3502 in the herbarium of the College of Hawaii;—Mauna Kea, Parker Ranch, 1909, Rock in herbarium College of Hawaii;—Kaluamakani crater, Mauna Kea, flowering July 1, 1909, Rock no. 3225 in herbarium College of Hawaii;—Waikii, Mauna Kea, flowering June 1910, Rock no. 8418 in herbarium College of Hawaii.

Sophora chrysophylla has also been collected by Menzies, Meyen, the U. S. Exploring Expedition, Remy, Mann and Brigham, Hillebrand, Forbes, Faurie, Curran, and others.

The *Mamani*, which may be found on all the islands with the exception of Molokai, grows from almost sea level up to nearly 10,000 feet elevation. It inhabits the high mountains of Hawaii, Mauna Kea, Mauna Loa and Hualalai up to 10,000 feet, where it forms the upper forest zone together with shrubby Composites, such as *Raillardia arborea* and *R. struthioloides* and other plants peculiar to these regions. On Kauai and Oahu it never grows to a tree, while on the slopes of Mauna Loa, on Hawaii, near the volcano of Kilauea, it reaches its best development. Trees of 40 feet in height are not uncommon at an elevation of 4000 feet. Below and above the snow-line it is covered with silvery-gray hair, which protects it from the severe cold which it experiences, not only during the winter, but also in the summer months. The writer experienced a temperature of 19° Fahr. during a night spent on Mauna Kea in the month of July.

The specimens from Haleakala have glossy leaves with a grey pubescence; the latter disappears from the upper side entirely, but remains on the lower surface. The Mauna Kea specimens have narrow leaves, as have those from Haleakala, Maui, while the trees from the higher slopes of Hualalai, Hawaii, have broad ovate leaves; the latter specimens have also the largest flowers.

The wood of the *Mamani* is exceedingly hard and very durable in the ground. It is therefore mainly used for fence posts by the cattle ranchers on the large estates on Hawaii. On Haleakala, Maui, the trees are of medium size, though reaching a similar development at Auahi as that found near the volcano of Kilauea at Puaulu on Hawaii. On the upper slopes of Haleakala they are shrubby. The wild cattle and horses, which are very numerous on the upper slopes of Mauna Kea, live almost exclusively on the young leaf shoots of the *Mamani* during the dry season, when there is no grass available. But, thanks to the hardiness of the trees, which are exceedingly deep-rooted, they are able to withstand the ravages of the descendants of Vancouver's cattle.

The *Mamani* is peculiar to the Hawaiian Islands, while *S. tomentosa* is found in the South Sea Islands, where it grows on the beach; in Viti or Fiji it is known by the name *Kau ni alewa*, or women's tree.

The *Mamani* is very closely related to *Sophora tetraptera* of New Zealand, Juan Fernandez, Lord Howe's Island, Chatham Island, Easter Island, and Chili.

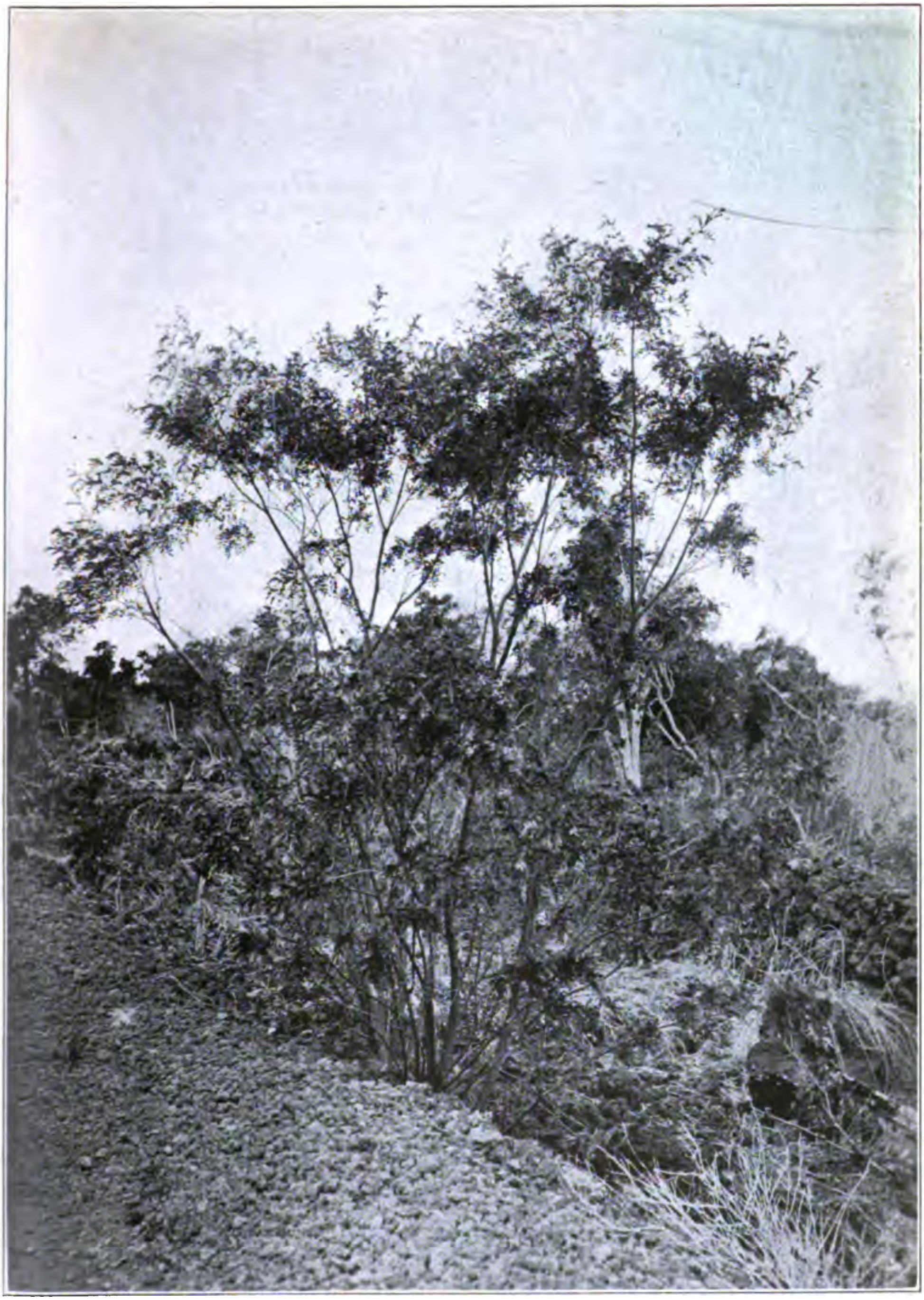
Sophora chrysophylla glabrata Rock
Edwardsia chrysophylla var. *β glabrata* A. Gray U. S. Explor. Exped. 459. 1854.

A shrub, 4-5 m. high, never a single trunk, more or less glabrate throughout, the leaflets are long, linear-oblong, 2.5 cm. long, 6-8 mm. wide, glabrate or slightly pubescent on both sides, flowers smaller of a paler yellow, calyx thin, brownish pubescent; the pods (in the Lanai specimens) with very narrow wings, the latter only 1 mm.

LANAI: On the plateau leeward side, near Koele, back of Gibson Homestead, flowering and fruiting July 29, 1910, Rock no. 8012 in the herbarium of the College of Hawaii.

Sophora chrysophylla was first recorded from Lanai, by the writer, and published in his book on "The Indigenous Trees of the Hawaiian Islands." The Lanai plant is certainly worthy of varietal rank and may be classed with Asa Gray's var. *β glabrata*. To this latter variety Asa Gray referred specimens from the lowlands of Hawaii. The writer observed *Sophora chrysophylla* as low as almost sea level at Puuwaawaa, North Kona, and elsewhere on Hawaii.

The plant from the lowlands of Hawaii belongs in all probability to Gray's var. *β glabrata*, but differs from the Lanai specimens in the much broader winged pods, while the plants from Lanai have wings only one millimeter in width. The variety



SOPHORA CHRYSOPHYLLA GLABRATA Rock
Mamani.
Growing on the lava flows of Puuwaawaa, North Kona, Hawaii;
elevation 2000 feet.

glabrata is always a shrub. It is peculiar to the arid ancient lava flows, where it grows in company with *Myoporum sandwicense, Nototrichium sandwicense, Dracaena aurea, Charpentiera obovata, Santalum Pilgeri* var. *luteum, Pittosporum Hosmeri, Rockia sandwicensis,* etc. At the same elevation on the slopes of Hualalai near Puuwaawaa occurs var. *unifoliata,* a much larger shrub or small tree, which may be described as follows:

Sophora chrysophylla unifoliata Rock var. nov.

A tall shrub or small tree, about six meters in height, with more or less straight branches, leaves simple not pinnate, broadly ovate-oblong up to 4.5 cm. long, 2.5 cm. wide, alternate on the woody branches, on petioles of 2-3 mm., finely pubescent on both sides; floral racemes terminal, pedicels 10-13 mm.; flowers small, pale yellow; calyx small 4 mm. high, pubescent, the lobes very broad and blunt; ovary densely pubescent; pods not seen.

HAWAII: Mr. Young without further locality, 1913, in the herbarium of the College of Hawaii, no. 12648;—Puuwaawaa, slopes of Hualalai, on old aa (rough) lava flow, elevation 2000 feet, flowering August 1917, Rock type no. 13011 in the herbarium of the College of Hawaii.

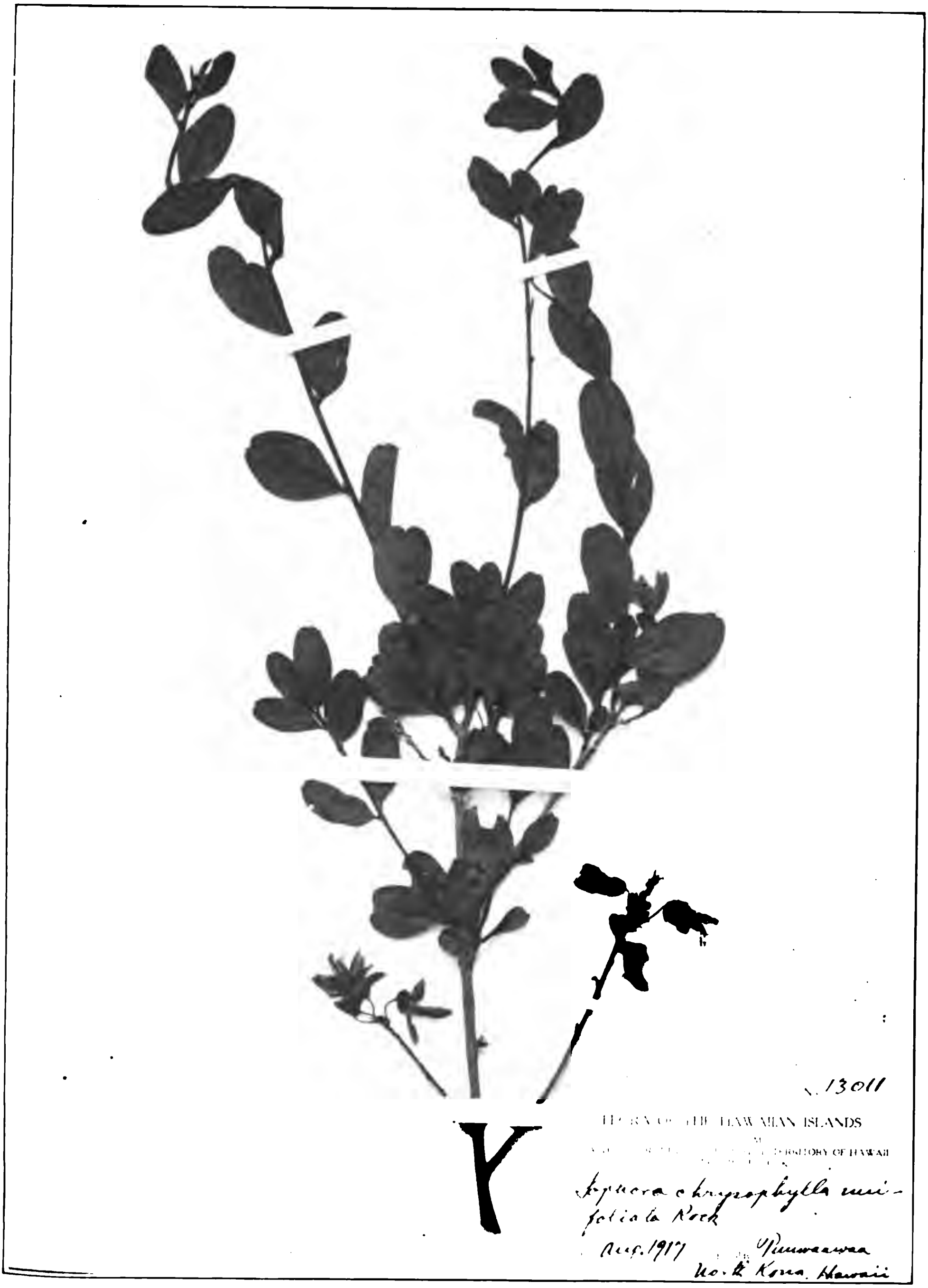
This variety was first discovered by Mr. Young of the fibre textile department of the United States Department of Agriculture. The writer met with a single tree at Puuwaawaa. Not one single pinnate leaf could be found on the tree.

ERYTHRINA L.

Guppy in his interesting work on seed dispersal ("Observations of a Naturalist in the Pacific") takes the viewpoint of *Erythrina monosperma* Gaud., the Hawaiian wiliwili, as having been derived from *Erythrina indica,* a widely-distributed species. This assertion would mean that *Erythrina monosperma* must have been once upon a time a shore species with buoyant seeds, and later became an inland species whose seeds lost their floating power due to location and environment.

Guppy simply quotes Drake del Castillo in regard to the rela-

PLATE XV.



Type of **Sophora chrysophylla unifoliata** Rock in herbarium College of Hawaii.

tionship of *E. monosperma* to *E. indica*, saying that the former is very nearly related to the latter and that the former differs from the latter mainly in the more hairy calyx, in the more permanently tomentose and much shorter pod, and in the paucity of seeds (one or two in number).

This viewpoint as regards relationship, the writer cannot share, and if Guppy had compared the pods of *Erythrina indica* with those of *E. monosperma* he could not have followed Drake del Castillo and adopted his statements without question. There is a very decided difference in the pod of *Erythrina monosperma* as compared with *E. indica*. The former dehisces on the tree, exposing the bright red (scarlet) seeds for a long time as they are firmly attached to the funis; the pod itself is hard and of a woody texture. When thoroughly mature the valves dehisce by becoming spirally twisted due to the heat of the sun, which shines from a cloudless sky wherever *Erythrina monosperma* occurs. In *Erythrina indica* the pod consists of a thick papery pulp which drops to the ground in its entirety, where it rots, but does not dehisce on the tree, and at no time are the seeds exposed while the pods hang on the tree, which is for a considerable period; the pods are indehiscent, thicky fleshy when green, the valves of which acquire the consistency of a thick papery pulp at maturity. The seeds are of a very dark brownish-carmine color, which hardly would attract birds. The Hawaiian species, however, with its scarlet seeds exposed for a considerable period in the bright sunlight, must certainly attract birds. The mature dehiscent seedpods exposing these bright red seeds can be seen from a considerable distance, while even the large but somber pods of *E. indica* are discernible only at close range.

According to Drake del Castillo, *E. monosperma* occurs in Tahiti and also New Caledonia; in the former island it inhabits the valley of Fautana at 2100-2400 feet elevation. It is, however, not the only species of *Erythrina* in Tahiti, as *E. indica* occurs on the beaches as a native tree.

Had *Erythrina monosperma* been derived from *E. indica,* and if the former was dispersed in bygone ages by means of ocean currents, why is it that the ancestor *E. indica,* which still has its buoyant seeds, is absent from Hawaii? And why is the satellite *E. monosperma,* with non-buoyant seeds, present in Hawaii?

The answers to these questions seem not to be difficult, especially after comparing the characters of the pods of the two species.

There is no doubt that *E. monosperma* is a much older species than *E. indica*, and that it belongs to a period of dispersal much antedating that of *E. indica*. On comparing the other species of plants found on the islands of the Eastern Pacific, especially of Tahiti, the Tonga and Cook group, with those of the islands of the Western Pacific, we find that the former are much older and in many respects quite peculiar, and that the endemicity is much higher than that of the species occurring in the Western Pacific islands, which received their plant stockings mainly from the Malayan region. The absence of *Lobelioideae* and the peculiar ancient arborescent *Compositae* of Hawaii and Tahiti, in the Western Pacific, would confirm the theory that the Western Pacific regions are undoubtedly younger. This question has been thoroughly discussed by the writer in his monographic study of the Hawaiian *Lobelioideae*.

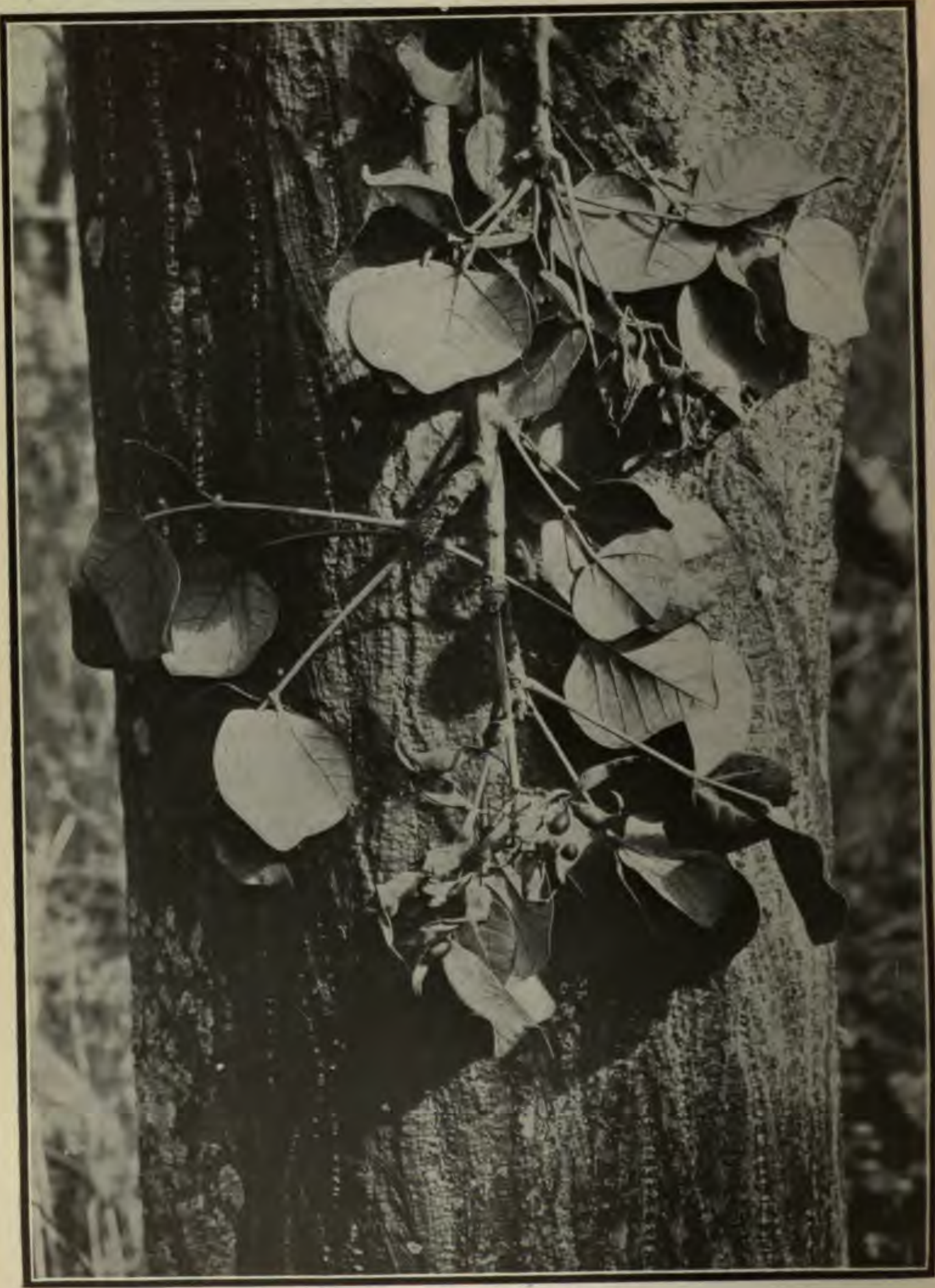
That *Erythrina monosperma* was dependent on birds for its dispersal is very probable, though the agent responsible for its distribution has long since passed out of existence. The peculiar dehiscence of the pod of *E. monosperma* on the tree, exposing the bright scarlet glossy seeds for a considerable period, would certainly indicate bird dispersal, as it would undoubtedly attract birds.

Guppy's contention that the seeds would swell too quickly if swallowed by a bird, and thus destroy the germinating power, is not correct, for seeds of that species may remain for weeks in water without the seed coating being destroyed or even wrinkled. The writer had seeds of *Erythrina monosperma* planted for months before they germinated, though they were kept in a hot moist atmosphere. Some, of course, germinate rather quickly, while others are extremely slow.

Erythrina monosperma Gaud. Bot. Voy. Uranie, 486, pl. 114. 1826.

Erythrina montana Forst. in Pancher, Herb., et in Cuzent, Tahiti, 240. 1860.

Erythrina tahitensis Nadeaud Enum. no. 499. 1873.



ERYTHRINA MONOSPERMA Gaud.

Wiliwili.

Showing trunk, bark, and fruiting branch. Lava fields near Puuwaawaa, Hawaii; elevation 2000 feet.

Corallodendron monospermum O. Ktze. Rev. Gen. Plant I:173. 1891.

A tree 6-10 m. high, sparsely aculeate with short conical prickles; trunk short or occasionally 5 m. long and vested in a thin yellowish bark with longitudinal ridges; crown broad spreading, with glabrous, stiff, gnarled branches, fulvo-tomentose at their ends; leaflets ovate-deltoid; broader than long, 5-6.5 cm. long, 6.5-9 cm. wide, obtuse, entire, truncate to subcordate at the base, chartaceous, tomentulous beneath; the petiole 8.5-25 cm. long, extending considerably beyond the lateral leaflets, petiolule of the terminal leaflet about 1 cm., that of the lateral ones about 5 mm. and articulate; stipules gland-like, one or two for the base of the petiole, one for each lateral and two for the terminal petiolule; racemes in the axils of the ultimate leaves, fulvo-tomentose, stout when with fruit, but often slender when with flower, nodose in the upper third, with one or two or three flowers at each node, 8-15 cm. long; bracts triangular, 2 mm. or less; pedicels 4-8 mm. with flower, 10-12 mm. with fruit; calyx thickly tomentose tubular-spathaceous, minutely toothed, 15 mm. or more long; standard 2.5 cm. in diameter (up to 5 cm. teste Hillebr.), scarcely stipitate; wings oblong obtuse 12 mm. (up to 18 mm. teste Hillebr.); keel 10-16 mm., its two petals free; stamens as long as the standard, the alternate ones shorter, that opposite the standard connate at the base; anthers pointed versatile; ovary tomentose, stipitate, three to five-ovuled, narrowing to a slender straight or curved style 15-20 mm. long; pod torulose, pubescent acuminate at both ends, coriaceous-ligneous, dehiscent 1- several-seeded; seeds scarlet or darker red, 15 mm. long, hilum elliptical 5 mm.; flowers brick red, orange or pale yellow.

KAUAI: Makaweli gulch, fruiting March 3-10, 1909, Rock no. 2156 in herbarium College of Hawaii.

OAHU: Koko Head, Rock no. 5839 in herbarium College of Hawaii.

MOLOKAI: Mahana, west end, fruiting March 1910, Rock, in herbarium College of Hawaii.

MAUI: Auahi-Kahikinui, southern slopes of Haleakala, Rock, in herbarium College of Hawaii.

LANAI: Mauna Lei, flowering and fruiting July 13, 1910, Rock no. 8118 in herbarium College of Hawaii.

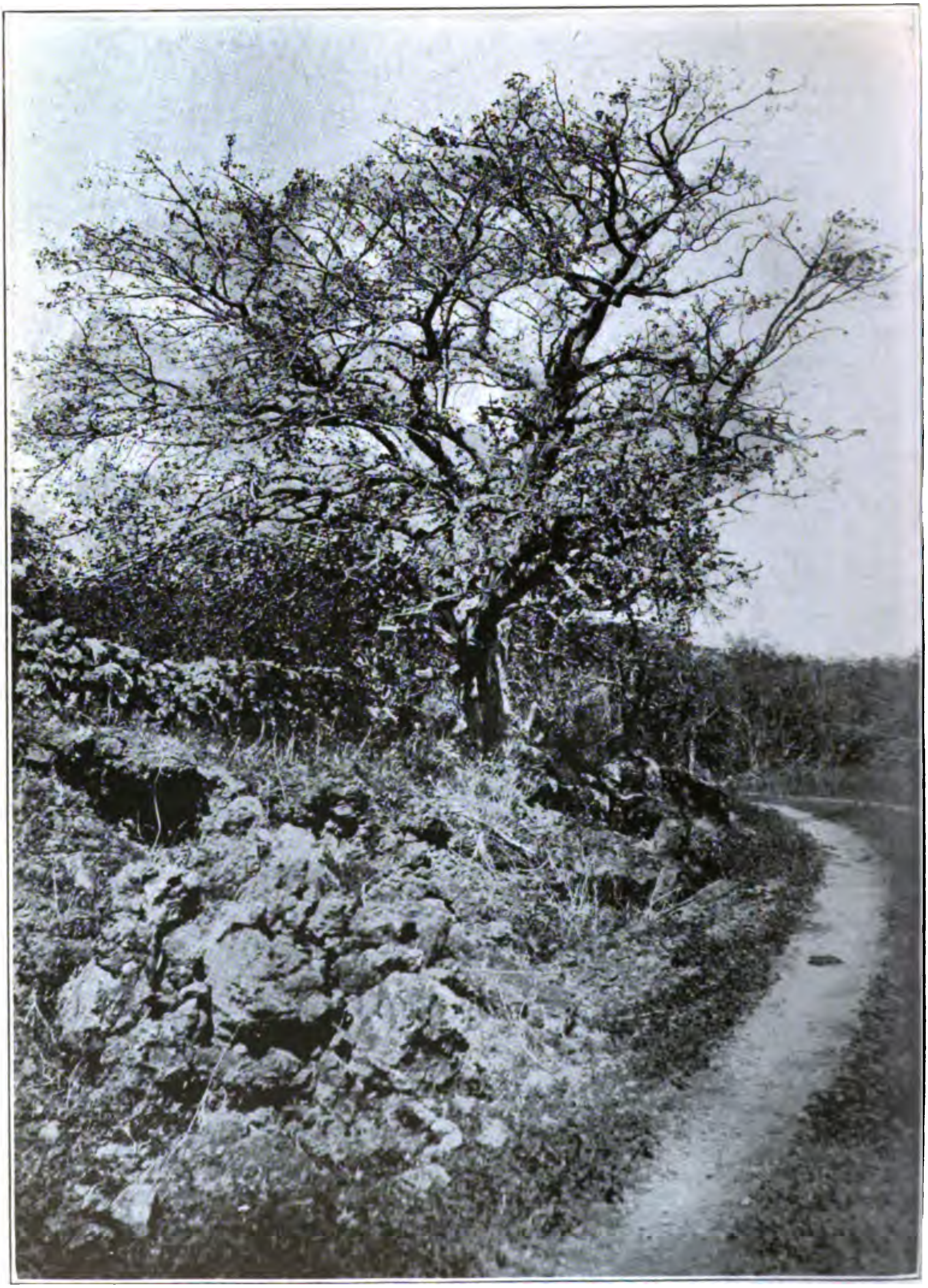
HAWAII: Puuwaawaa, N. Kona, Rock in herbarium College of Hawaii;—observed at Kapua, S. Kona, Naalehu, Hilea, Kau, etc.

KAHOOLAWE: Observed by R. S. Hosmer.

Specimens with pale yellow flowers were observed both on Lanai and Hawaii.

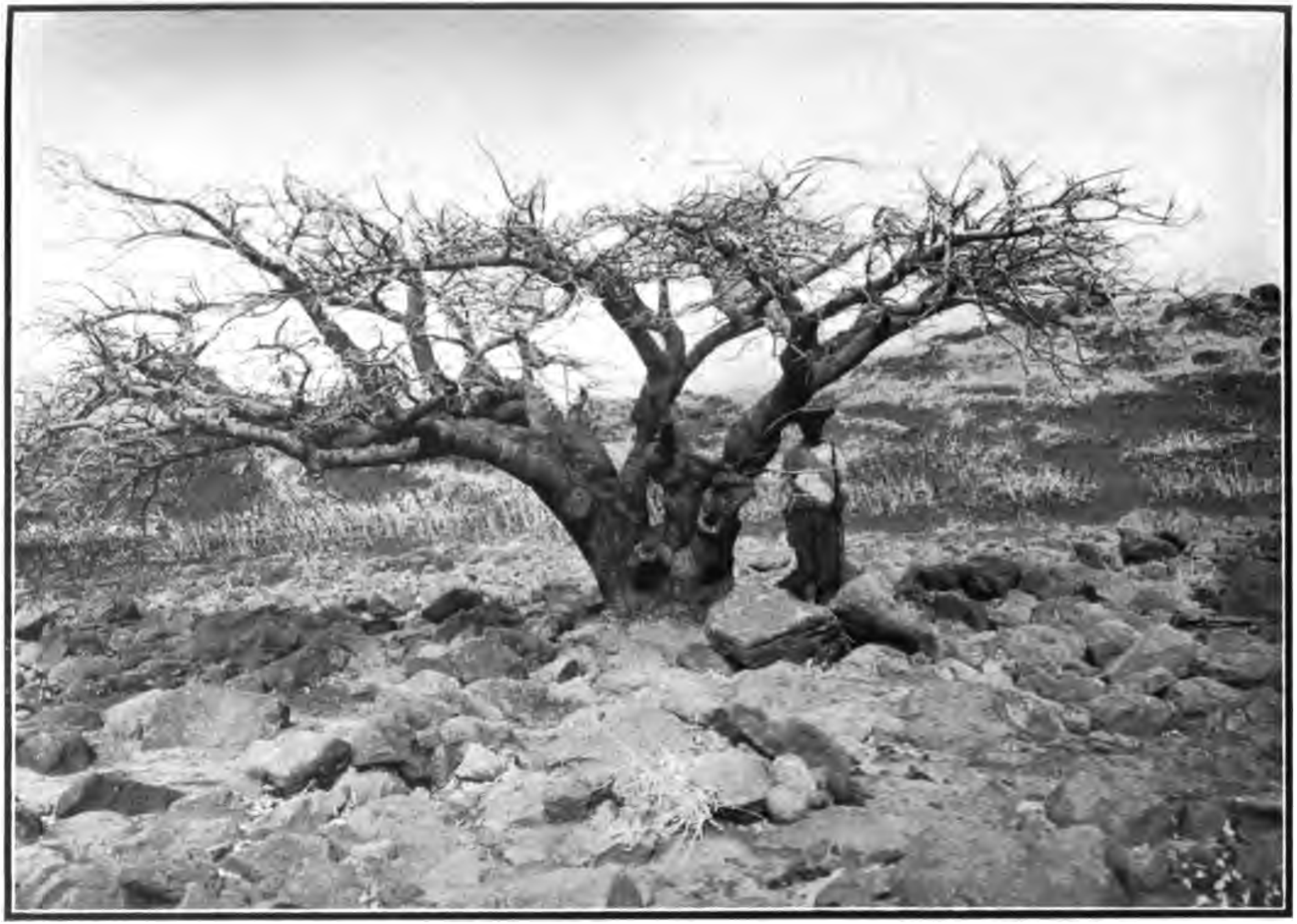
The native name of this tree is *Wiliwili.*

E. monosperma inhabits the dry regions on all the islands of



ERYTHRINA MONOSPERMA Gaud.
Wiliwili.
Growing on the lava fields of Puuwaawaa, North Kona, Hawaii;
elevation 2000 feet.

PLATE XVIII.



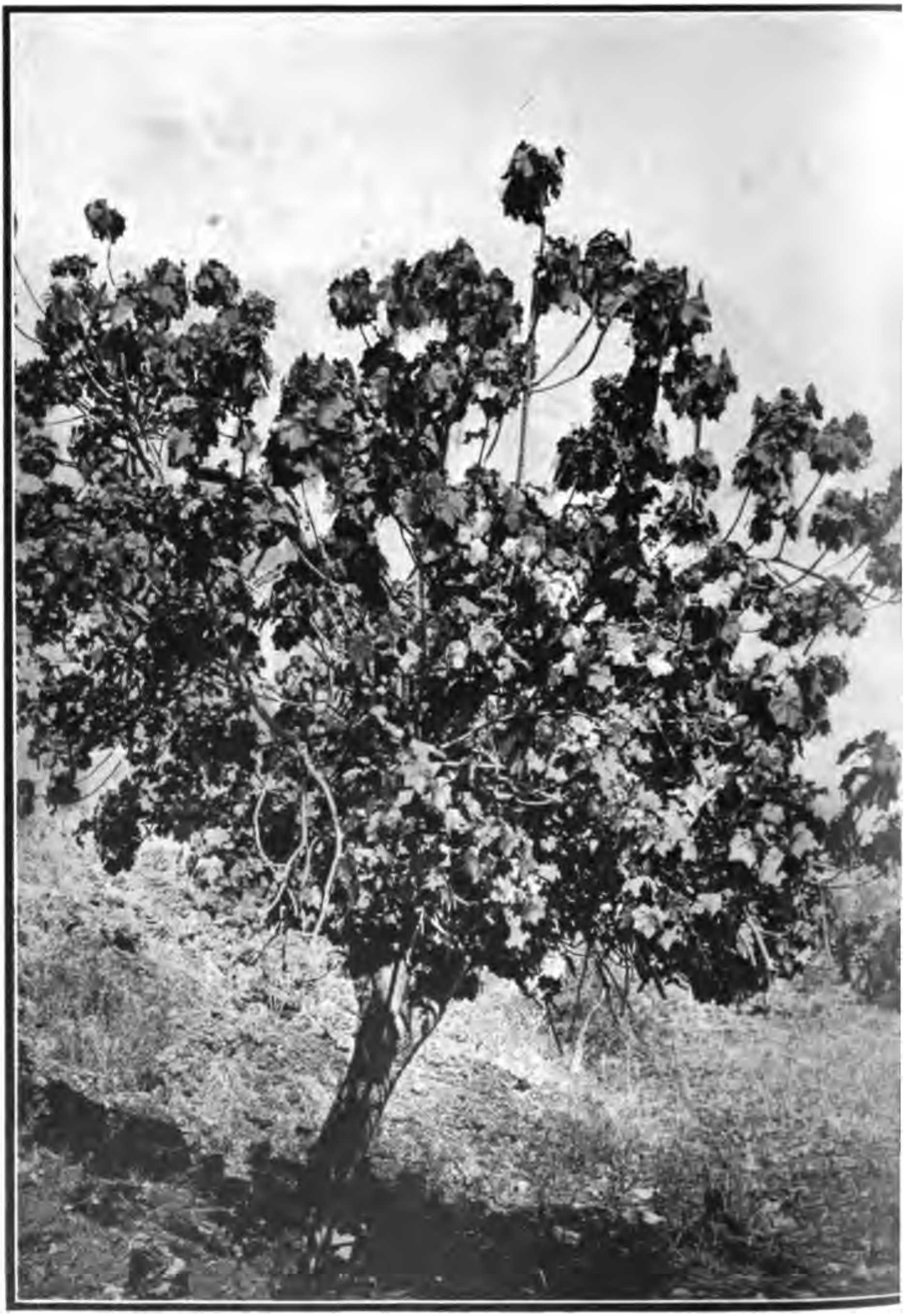
ERYTHRINA MONOSPERMA Gaud. (**Wiliwili**), the only native tree species left on the barren island of Kahoolawe.

the archipelago. It occurs from about 500 feet elevation to 2000 feet, but rarely higher. It loves the hot arid lava flows, and is always found on the leeward side and never on the windward side of the islands. On Kauai it may be found in Waimea canyon, the rocky slopes back of Kekaha and Waimea, and also on the drier part of the Haupu range. On Oahu it is common in the valleys of the Waianae range, as at Mokuleia, etc., also on the extreme eastern end of the Koolau range at Wailupe, Niu and Koko Head. On Molokai it occurs back of Kaunakakai, and must have been very common all over the western end of the island, where it still occurs in clumps or as isolated individuals in dry canyons. It is associated with *Reynoldsia sandwicensis, Gardenia Brighami, Plectronia odorata, Xylosma Hillebrandii, Kokia drynarioides, Osmanthus sandwicensis, Breweria Menziesii, Maba sandwicensis, Chrysophyllum polynesicum* and *Nototrichium sandwicense.* On Maui it is not uncommon back of Makawao and especially so on the southern slopes of Haleakala at Auahi and Kahikinui, where it grows with some of the species above mentioned and *Rauwolfia sandwicensis,* species of *Pittosporum, Alectryon macrococcus, Pelea Knudsenii* var. *multiflora* and others. On Lanai it can still be found on the slopes back of Manele, as well as in the deep and arid gorges of Mauna Lei and Nahoku, also in the desert region of Kaa. On Hawaii it is still most numerous, especially on the lava flows of both North and South Kona and Kau. It forms practically a belt around that part of the island, beginning at Hilea, through Manuka, Kapua, Honomalino, Papaa, Kealakekua, Huehue, Puuwaawaa to Puuanahulu, Kawaihae-uka and Puukawai near Waimea. Its associates in Kona are *Mezoneurum Kauaiense, Dracaena aurea, Charpentiera obovata* var., *Alphitonia excelsa, Colubrina oppositifolia, Kokia Rockii, Sideroxylon auahiense* var. *aurantium, Pittosporum Hosmeri* and its variety *longifolium.* In the Kona district it develops huge trunks of several feet in diameter, which are of a dirty orange yellow; the flowers are either red, brick red, yellowish or white. The trees are often festooned with *Canavalia galeatea* var. *pubescens.* Even the island of Kahoolawe still supports a few trees of this species, about the only native tree in existence there.

It is on the islands of Kauai, Molokai and especially Oahu that the tree is on the verge of extinction, while on Hawaii it is still abundant owing to the uselessness of the land on which it grows, being mainly found on rough *aa* lava flows inaccessible to cattle, the arch enemy of Hawaiian trees and forests in general.

The wood of the *Wiliwili* is soft and very light, and was used by the Hawaiians for the float in the outrigger of their dug-out canoes.

PLATE I. (Frontispiece)



KOKIA ROCKII Lewton
Kokio tree.
Growing on the lava flows of Puuanahulu, Kona, Hawaii; elevation 2500 feet.

BOTANICAL BULLETIN No. 6. JUNE, 1919

Territory of Hawaii
BOARD OF AGRICULTURE AND FORESTRY

DIVISION OF FORESTRY
C. S. JUDD, *Superintendent*

The Hawaiian Genus Kokia

A RELATIVE OF THE COTTON

BY

JOSEPH F. ROCK
Consulting Botanist

ISSUED JUNE 9, 1919
HONOLULU, HAWAII

LETTER OF TRANSMITTAL

HONOLULU, HAWAII, May 3, 1919.

Board of Commissioners of Agriculture and Forestry,
Honolulu, Hawaii.

GENTLEMEN:

I have the honor to transmit herewith the manuscript of a paper entitled "The Hawaiian Genus *Kokia,* a Relative of the Cotton," by Mr. Joseph F. Rock, *Consulting Botanist of the Division of Forestry* and also *Botanist of the College of Hawaii,* and to recommend that it be published as Botanical Bulletin No. 6 of the Division of Forestry.

The paper treats of the very rare members of this most interesting genus of which one species has already become extinct, and it is hoped that its publication will arouse interest in the preservation and cultivation of these rare species.

Very respectfully,

C. S. JUDD,
Superintendent of Forestry.

Approved:
Board of Commissioners of Agriculture and Forestry,
May 5, 1919.

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THE GENUS *KOKIA* IN THE HAWAIIAN ISLANDS.

In the year 1912 Fredrick L. Lewton* established the genus *Kokia*, based on material furnished him by the writer of a species of a tree belonging to the family *Malvaceae*.

The genus as understood by Lewton consists of three species, viz: *Kokia Rockii*, the type of the genus; *Kokia drynarioides*, and *Kokia lanceolata*.

Kokia Rockii was first discovered by the writer in June, 1909, although the tree was well known to the old natives of the island of Hawaii and particularly to the natives of North Kona, to which locality the species is peculiar. When the species was first found by the writer he thought it to be identical with a closely related species occurring on the dry, west end of Molokai, where a species of that genus was first collected by Nelson, the companion of Captain Cook. The specimens collected at that time were quite fragmentary and were described by the celebrated botanist Berthold Seeman in the genus *Gossypium* under the specific name *drynarioides*.

To Dr. Hillebrand belongs the credit of finding another species, but not so recognized by him, on the eastern end of the island of Oahu. The specimens in existence are extremely meagre and fragmentary. It was listed in his famous work on the "Flora of the Hawaiian Islands" as a variety β of *Gossypium drynarioides* Seem. Prof. Lewton, whom the writer furnished with material of two species, the Hawaii and Molokai species, correctly recognized the species as not belonging to the genus *Gossypium*, but to a new genus "*Kokia*," closely related to *Gossypium*.

The genus was then only known from Oahu, Molokai and Hawaii.

On April 2, 1919, Mr. Augustus F. Knudsen of Kekaha, Kauai, an ardent naturalist like his father Valdemar Knudsen, from whom Dr. William Hillebrand received all his Kauai botanical material, addressed a letter to the writer, and enclosed some fragmentary specimens with the request to identify the same. He stated: "It is the only tree of its kind known to me on Kauai." The specimen sent was immediately recognized as belonging to the genus *Kokia*. The enthusiasm of a botanist may be imagined at the finding of such a rare and beautiful species of the genus *Kokia*. The writer immediately sent a wireless stating that he would appear on Kauai by the next boat. The specimen sent by mail was too fragmentary to permit the identification with any of the three known species.

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* Lewton, Frederick L. Kokia. A new genus of Hawaiian Trees. Smithsonian Misc. Coll., Vol. 60, part 5, Oct. 22, 1912.

The occurrence of a species of *Kokia* on Kauai confirms the belief that the genus was spread over the whole group and was probably also present on Maui and Lanai and perhaps Niihau and Kahoolawe. The *Kokia* trees have numerous enemies, the worst being cattle, which feed on the succulent leaves and fleshy branches, while the natives stripped off their bark for the sake of a dye which they extracted for the preservation of their fish nets.

The writer, accompanied by Mr. A. F. Knudsen and his brother, Mr. Eric A. Knudsen, immediately on arrival mounted horses in search of the tree. The tree could not be located by anyone not familiar with the country, no matter how detailed a description of the locality might be given. The party climbed the cliffs of Mana, the extreme western end of Kauai, composed of barren volcanic cliffs, the main vegetation of which is composed of the *pili* grass, *Andropogon contortus*. After a ride of several hours, crossing gulch after gulch, the party arrived at the canyon of Koaloha, in which is located the only *Kokia* tree now known from Kauai. It grows in company with the *Kukui*, *Aleurites moluccana*, whose leaves the *Kokia* greatly resemble, making it very difficult to distinguish the tree from the *Kukui*, especially at a distance.

The Kauai *Kokia*, which is a tree about 30 feet in height, owes its survival to a cliff about 15 feet in height on the edge of which it grows, the trunk and crown inclining over the cliff so that cattle can not reach it.

Mr. Knudsen informed the writer that he saw the identical tree 20 years ago, but that he could not locate it again until he stumbled onto it in a recent cattle drive.

The tree was full of flower buds, none of which had opened, but one was just about to open. Specimens were collected and the ground was searched for a whole hour in an effort to find mature seeds. Seven seeds were found in all, including a perfectly mature capsule.

Mr. Knudsen states that he has seen the tree loaded with flowers, about 2000 flowers being observed at one time, each individual flower being from seven to nine inches across. The flowers are of a brilliant red, and when the tree is in full bloom it is an object of great beauty.

On examination it was found that the tree is related neither to the Molokai nor to the Oahu species, but is exceedingly close to *Kokia Rockii* of Hawaii, from which it differs sufficiently in size of flowers, leaves, pubescence, capsule, etc., to make it worthy of a varietal rank. It is therefore here named as *Kokia Rockii Kauaiensis.*

HISTORY OF THE OLD SPECIES.

As has already been stated, *Kokia drynarioides* was discovered by Nelson, the companion of the great circumnavigator Captain Cook, and was described by Seeman* very briefly in his "Flora Vitiensis." Dr. William Hillebrand received specimens of this species from a Mr. R. Meyer, an old resident of Molokai, who discovered three trees which could not be located again by Dr. Hillebrand. In April, 1910, the writer found a single tree of that species in a lonely, dry canyon at the extreme west end of Molokai back of Mahana. It was a small, stunted tree about 10 feet in height. Although it was full of fruit and leaves, it showed signs of decay, so that the passing of a year or so would find the species extinct.

The region in which this rare species grew is one of the weirdest and loneliest imaginable. The tree stood on a rocky bluff all by itself. Some distance from it there were the remnants of a forest, a few scattered trees of *Osmanthus sandwicensis, Nototrichium sandwicense, Xylosma Hillebrandii, Maba sandwicensis, Chrysophyllum polynesicum* and the exceedingly rare vine *Breweria Menziesii,* which clinged for support to an old decaying

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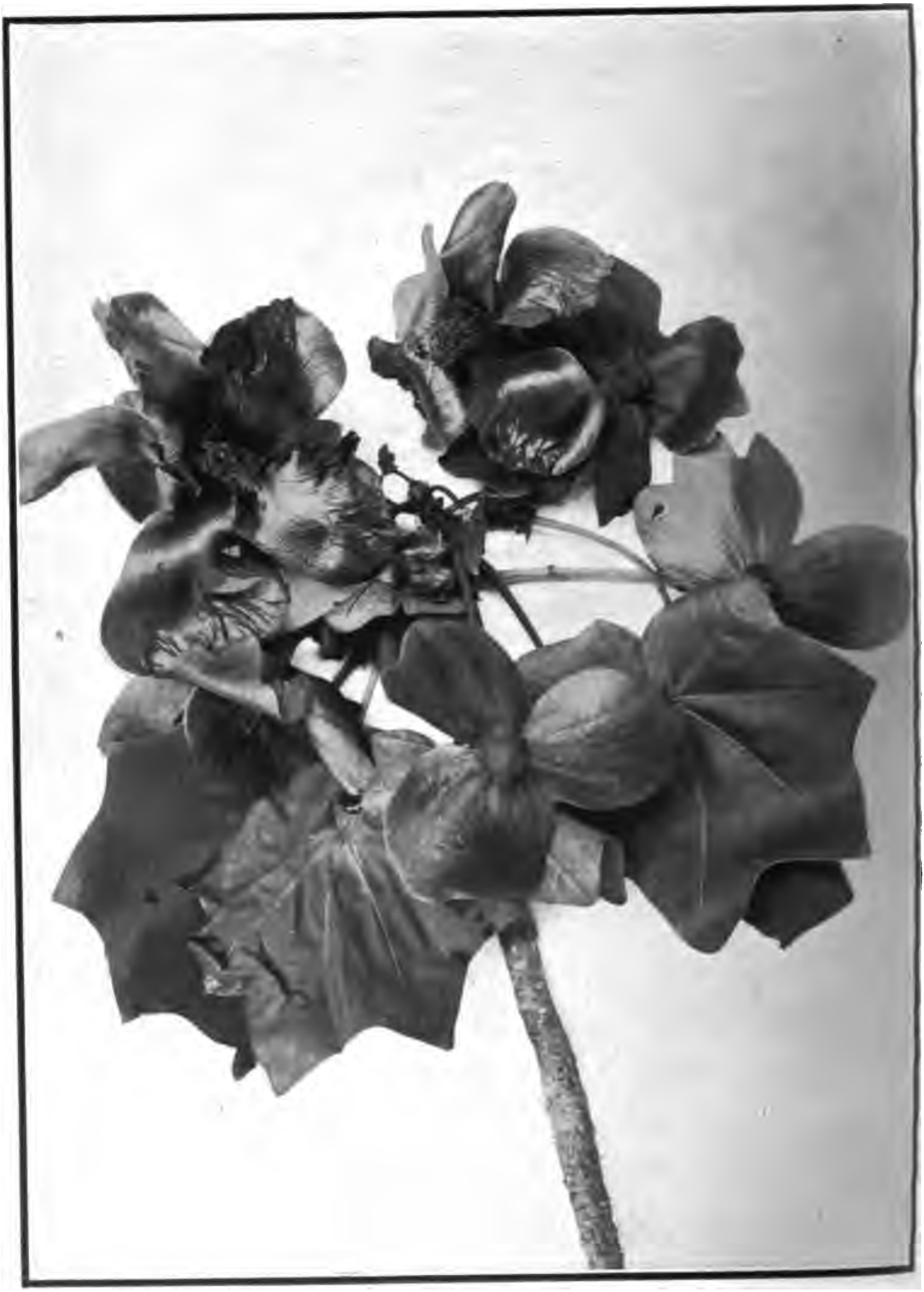
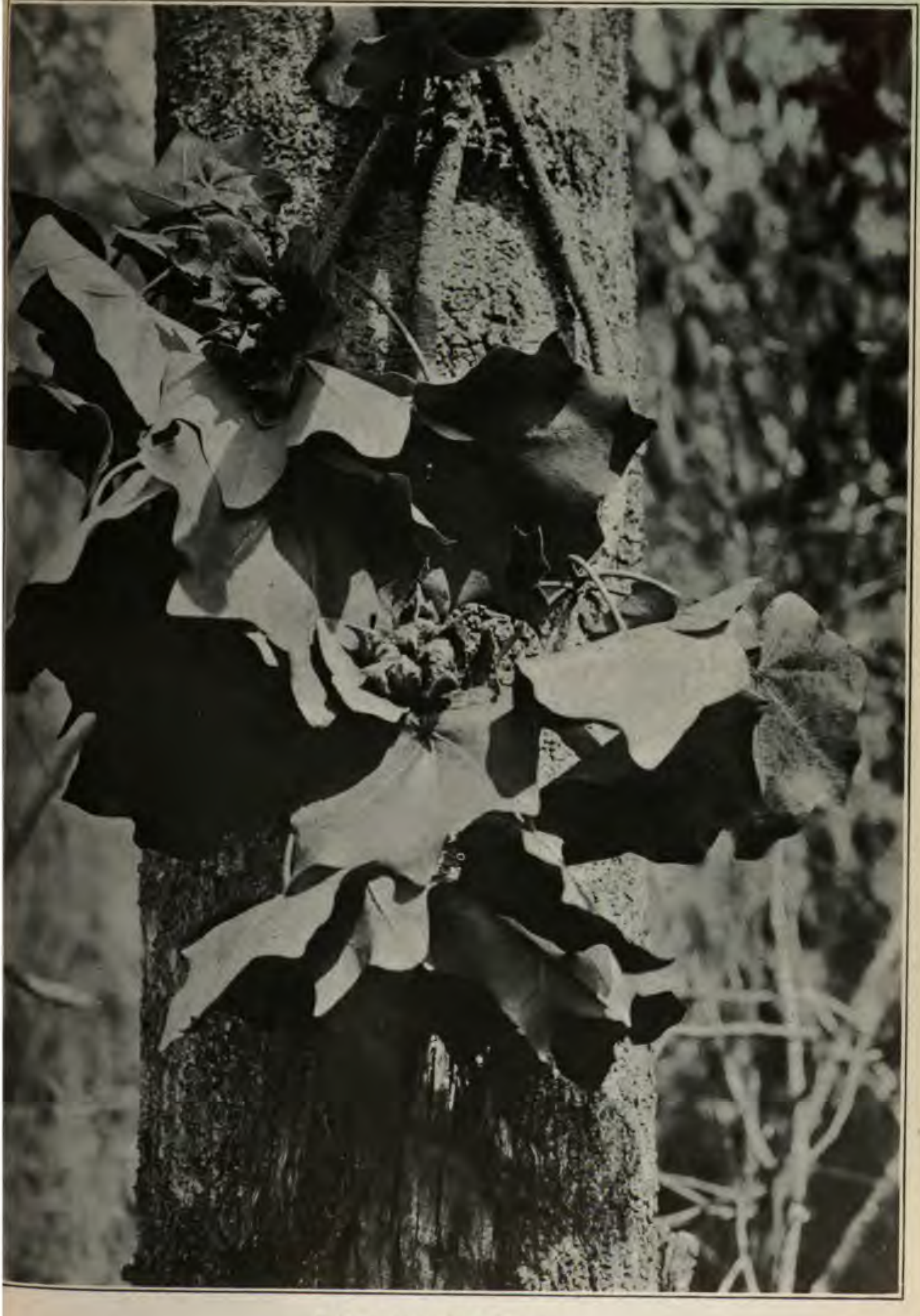
* Seeman in Fl. Vit. 22. 1865.



KOKIA ROCKII Lewton
Kokio.
Flowering branch, flowers bright red of silky texture. About one-third natural size.



KOKIA ROCKII Lewton

Fruiting specimen pinned against trunk of tree.

Maba tree. All the trees were windswept, the crowns extending in oblong outline in one direction. On the ground lay scattered old trunks of once glorious trees, and among them a small dead tree of *Kokia drynarioides,* probably one of the original three trees discovered by R. Meyer, and perhaps the very same from which Nelson collected his fragmentary specimens.

In June, 1915, the writer made another visit to the then only living tree of *Kokia drynarioides.* It was nearly dead, only one or two branches still bearing foliage. There were neither flowers nor fruit on the tree. A search on the ground rewarded the writer with a few seeds, some of which were grown in Honolulu, and one of which was planted on Molokai by Mr. C. C. Conradt, at Pukoo. The rest were forwarded to Mr. David Fairchild, Agricultural Explorer of the Bureau of Plant Industry at Washington, D. C.* Unfortunately, the seedlings grown in Honolulu died on account of the excessive rains during the winter of 1915-16.

While on Molokai in 1918 the writer visited the tree again, but it had died; only the worm-eaten, barkless trunk and branches remained of the last of its race.

There are now two living trees in cultivation on Molokai. One is at the residence of Mr. C. C. Conradt, at Pukoo, where the tree has already flowered and fruited for the first time this spring (1919), four years after planting from seed. The other is at the residential grounds of Mr. Geo. P. Cooke. This latter tree is older than the Pukoo tree, but is now beginning to flower for the first time. It grows at an elevation of about 2000 feet.

A few seeds secured from the Pukoo tree have been planted in Honolulu with the hope of getting it established here. Two seeds were sent to Mr. Fairchild.

Kokia lanceolata Lewton

No living specimens of this species are in existence. While in Europe in 1914, the writer worked on the Hillebrand collection at Dahlem, and through the kindness of Prof. Engler secured many duplicates from Hillebrand's herbarium, among them a

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* In a letter dated April 23, 1919, Mr. Fairchild writes: "You will be interested to know that we have a plant about five feet tall growing vigorously at our garden at Buena Vista, near Miami, Florida."

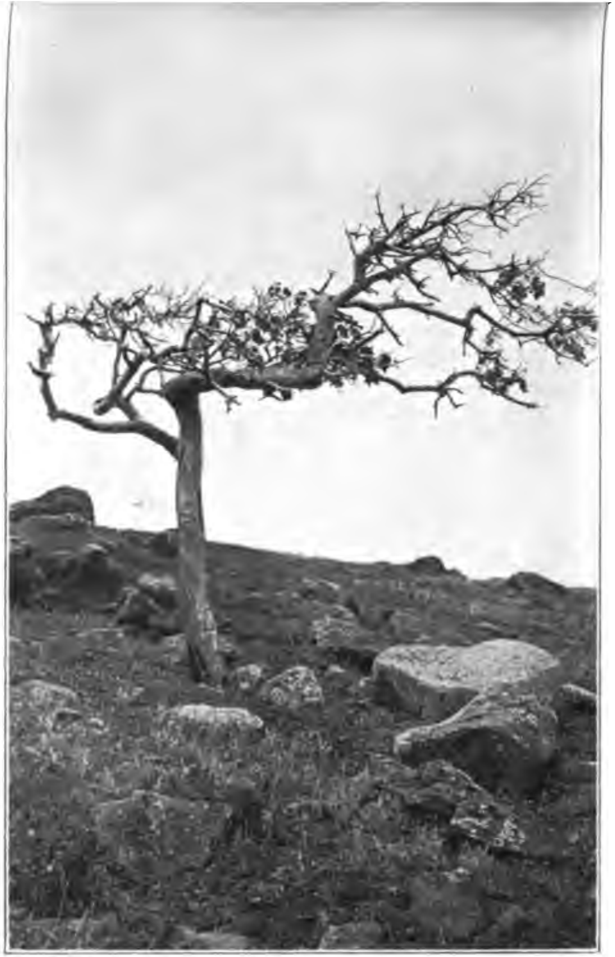

Fig. 1. **KOKIA DRYNARIOIDES** Lewt.

The last of the Molokai Red Cotton as it appeared in 1915. It is now a thing of the past.

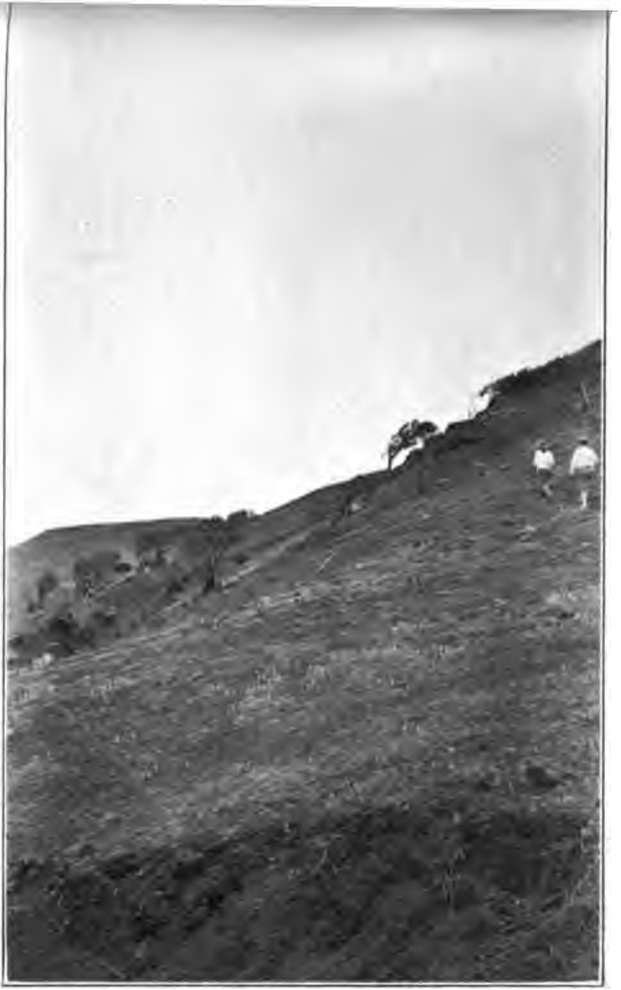

Fig. 2. The region on the west end of Molokai (Mahana) where the Red Cotton grew.

specimen of *Kokia lanceolata.* While the specimen is fragmentary, it is practically the best in existence. It was collected by Hillebrand on the island of Oahu in the valley of Wailupe, at the eastern end of the island. The writer searched Wailupe to find the species again, but without avail.

The leaves of *Kokia lanceolata* differ considerably from those of *Kokia Rockii* and the other species and variety. They are not cordate, but subtruncate at the base and without a sinus. The bracts are narrow, lanceolate. No flowers or fruits are extant of this species.

Kokia Rockii Lewton

A number of trees of this species are still in existence. They grow in the dry district of Puuwaawaa, North Kona, Hawaii, on rough *aa* lava flows.

Mr. Robert A. Young and Mr. Paul Popenoe published an article on "Saving the *Kokio* Tree" in the Journal of Heredity of January, 1916.*

The writer regrets to relate that the protective measures undertaken or supposedly undertaken to save that species were never thoroughly carried out, due to lack of interest on the part of the owners or lessee of the land and the Government in general. It is true that a few walls of lava rock were erected around a couple of trees or so, but so close to the trunk that the inner margin of the wall was not more than a foot distant from the trunk. Since then the walls have fallen down, due to the rummaging of cattle and goats, and the trees are as unprotected as ever.

One tree of this species has been planted on the College of Hawaii grounds, where it has reached the height of six feet, and seems well established. Others are being grown to be planted out at the College arboretum.

Kokia Rockii **Kauaiensis** *Rock* n. var.

An erect tree about 10 m. high, with ascending branches; leaves in whorls at the ends of the branches, somewhat fleshy of a deep green color, palmately 10-nerved; the leaves orbicular in outline with broad deltoid obtuse lobes 8 to 10 in number, the intervening sinuses very shallow, the leaf bases overlapping dextrorsely and sinistrorsely, 15 to 25 cm. in diameter, covered with a transparent areolar network and punctate throughout with blackish dots, glabrous above and beneath, but hirsute on both sides, with yellowish brown hair at the place of attachment of petioles; petiole fleshy thickly punctate with black dots, 5 to 8.5 cm. long; flowers single in the axils of the leaves; peduncle stout, 3 to 4 cm. long, bracteolate below the middle; the three bracteoles persistent, sessile broadly ovate sinuate, chartaceous, greenish red in color, more or less prominently nerved, glabrous above, hirsute with scattered yellowish hair beneath, especially along the middle of the bract, 15 cm. long, 13 cm. wide, each bract free to the base, the broad bases overlapping; calyx densely hirsute with yellowish hair, the ring of stiff brownish hair at the base of the calyx tube missing; flowers up to 22 cm. in diameter (teste A. Knudsen), bright red, the petals densely silky pubescent outside with yellow hair; capsule larger than in *Kokia Rockii*, ovoid, 3.75 cm. high, woody, acuminate; seeds broadly angular, larger than in the species, lint longer.

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* **Saving the Kokio Tree. Robert A. Young and the Editor "The Journal of Heredity," Vol. 7, No. 1, January, 1916.**

> KAUAI: Koaloha Canyon, region of Mana, in company with *Aleurites moluccana, Nototrichium viride, Osmanthus sandwicensis,* etc., flowering and fruiting April 12, 1919, Rock and Knudsen no. 16037, type, in herbarium, College of Hawaii.

This variety differs from the species in the larger leaves and flowers, the larger ovoid-oblong capsule, the densely hirsute calyx and in the absence of the ring of stiff brownish hair at the base of the calyx tube.

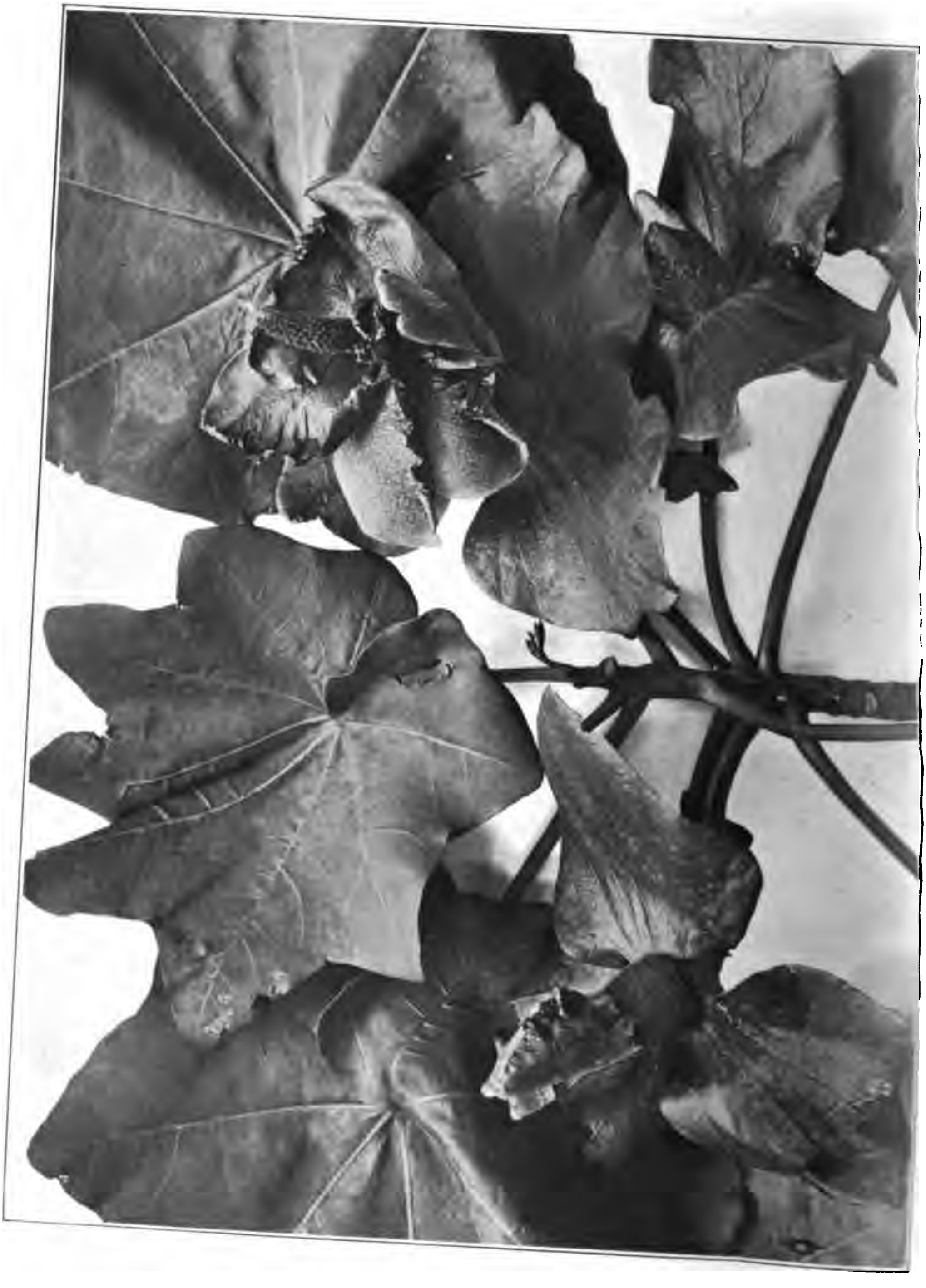
Kokia lanceolata Lewt.

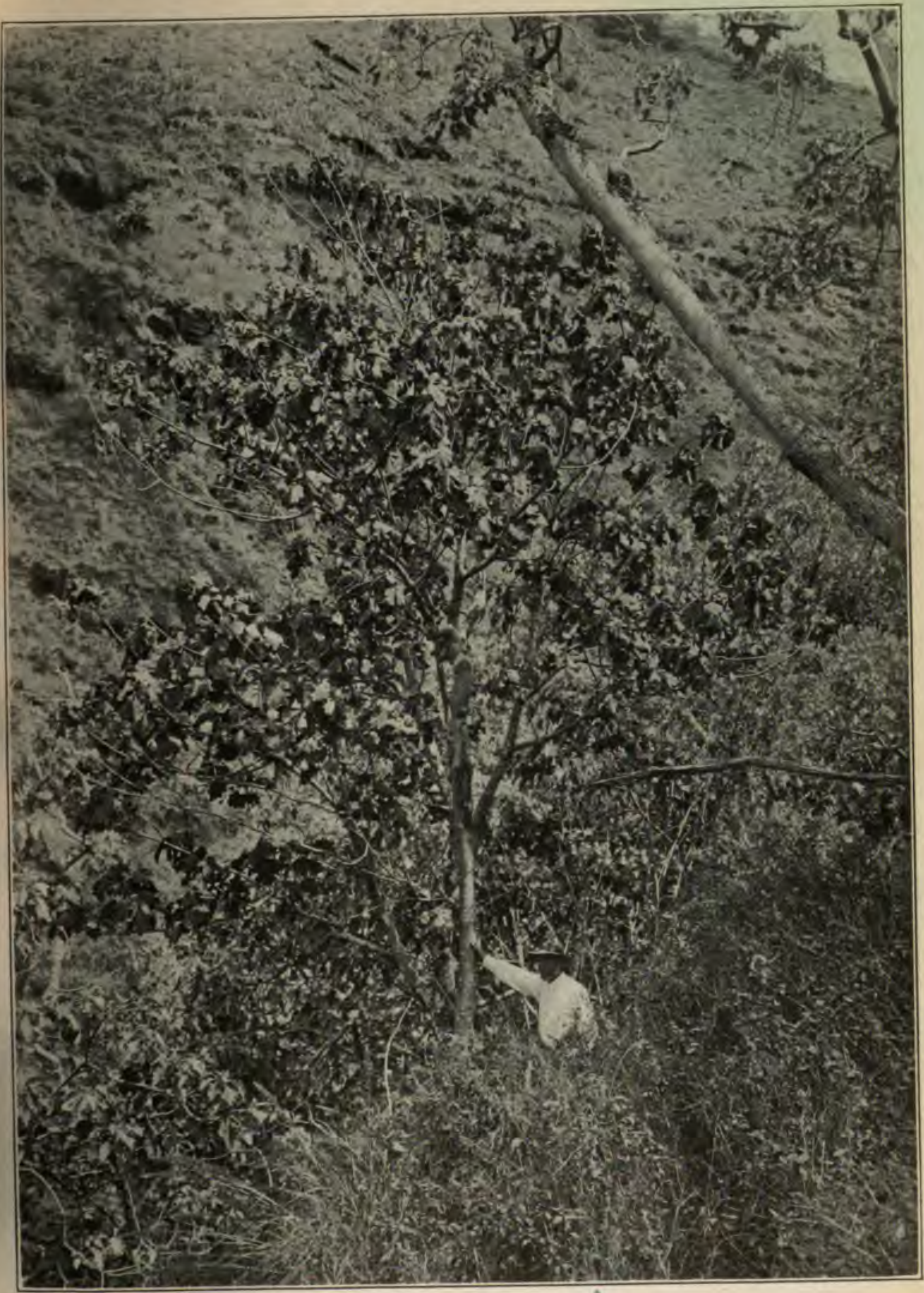
Gossypium drynarioides var. β Hillebr. Flora Haw. Isl. 51. 1888.

Kokia drynarioides lanceolata (Lewt.) Rock Indig. Trees Haw. Isl. 307. 1913.

Leaves much smaller than in the other species, 12.5 cm. wide, 7.5 cm. long, deeply sinuate, the middle lobes 3.75 cm. long, the lower lobes diminishing in size towards the base, the last lobes

PLATE V.





KOKIA ROCKII KAUAIENSIS Rock, with its discoverer,
A. F. Knudsen.
The tree, the only one known from Kauai, grows in the dry canyon of Koaloha in the Mana region of Kauai.

widely separated by a broad sinus, (base subtruncate) instead of overlapping as in the other species; petiole 13.75 cm. long; peduncle less than 5 cm. long, bracteate below the middle, the three bracts below the calyx tube, lanceolate, 3.75 cm. long, 12.5 mm. wide, glabrous above, pubescent beneath, several nerved, the veins parallel; calyx tube broadly campanulate, glabrous, shining, but with scattered black warts as in the other species; flower bud, densely hairy with yellowish silky hair outside.

OAHU: Wailupe Valley, Hillebrand in Herbarium Berlin and College of Hawaii Herbarium no. 16041.

Hillebrand, who collected this rare species, reports it from the eastern end of Oahu on the hills of Makaku and Koko Head. Two trees were seen by him. The specimen in the Berlin Herbarium is labeled as coming from Wailupe Valley. There is no doubt that this interesting species has become extinct, as a careful search of the eastern part of Oahu, including Wailupe Valley, was without success.

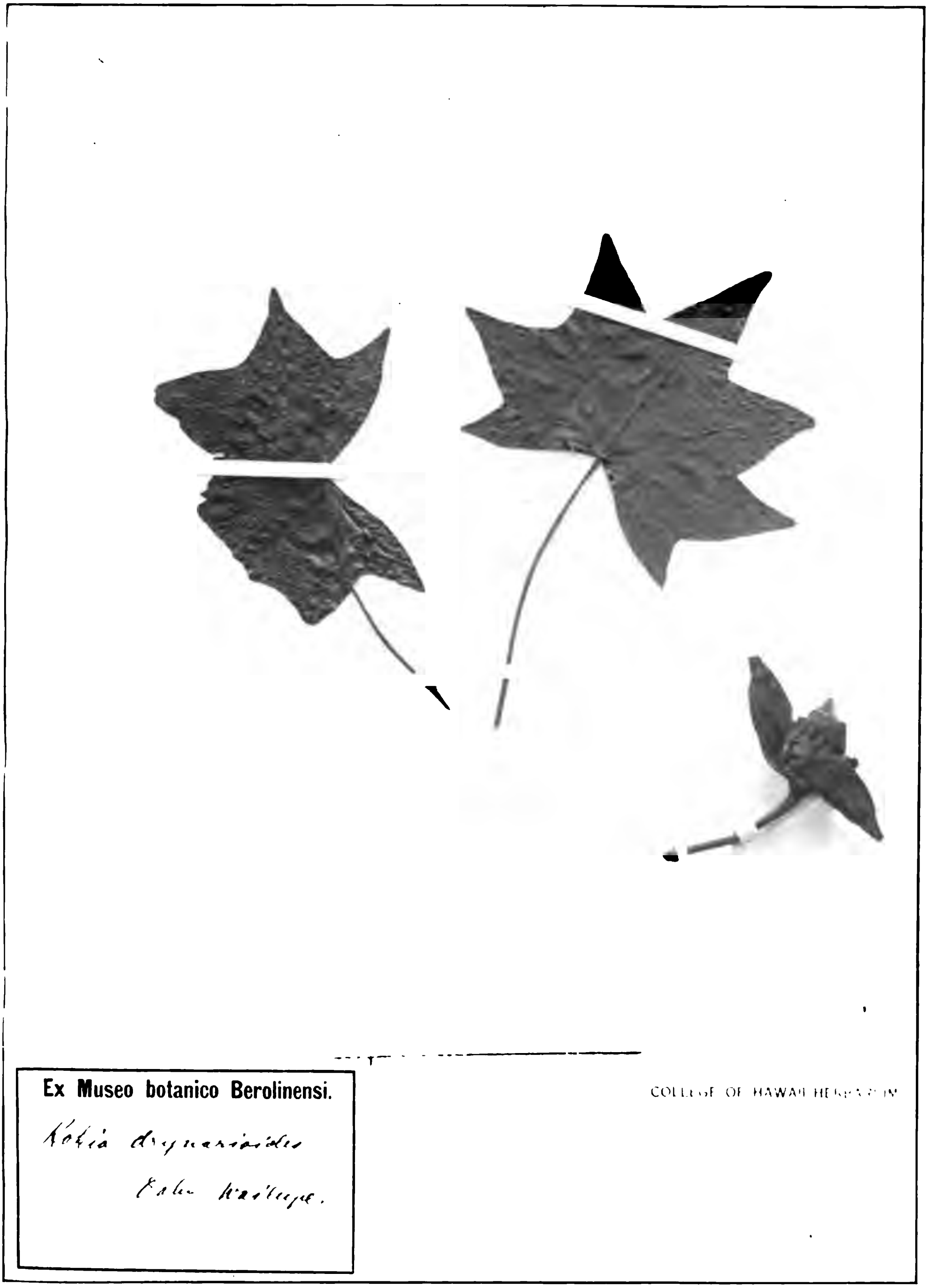
Hillebrand himself expressed the fear that this rare tree was doomed to extinction owing to its being accessible to cattle.

CONCLUSION.

It is remarkable that the Hawaiian Islands should have contributed two endemic genera to the not very large family *Malvaceae*. One is the present genus *Kokia*, the other the genus *Hibiscadelphus*.

Of other *Malvaceae* the Islands possess a number of endemic species, the most interesting being the various species of *Hibiscus*. The most noteworthy genus next to *Hibiscadelphus* is the genus *Kokia*, and perhaps more so, since the members of the genus *Kokia* may prove to be of economic importance. In the article on "Saving the *Kokio Tree*," by Young and Popenoe, these authors state: "In itself it appears to have no economic importance; but since the rise of the science of genetics has given breeders such a keen realization of the value of the wild relatives of important cultivated plants, it was possible that this wild cotton should escape consideration as of possible value in hybridization with the low-growing species commonly cultivated. But when the attempt was made to get this tree-cotton it was found to be

PLATE VII.



KOKIA LANCEOLATA Lewton

almost too late. There was grave doubt as to whether the tree could be saved from absolute extinction. It is the purpose of this paper to describe the measures by which an exceedingly rare plant of great interest has been saved from perishing altogether."

In concluding their article the authors state: "It is to be hoped that equally successful efforts will be made to save other wild relatives of cultivated plants, not only from sentimental reasons, but because any one of them, even the least promising in appearance, may turn out, in the hands of plant breeders, to be of great value to the world's agriculture."

The writer would recommend that steps be taken immediately, not only to protect properly the present living trees, but also to make arrangements whereby the seeds of these valuable trees are collected every year for the purpose of propagation. Young plants should be set out in some of our dry forest reserves, or even back of Honolulu, on Tantalus or Punchbowl, as these trees thrive well at lower elevations in hot, dry situations.

TERRITORY OF HAWAII

Board of Agriculture and Forestry

DIVISION OF FORESTRY

C. S. JUDD, Superintendent

REPORT
OF THE
Division of Forestry
FOR THE
Biennial Period Ended December 31, 1920

Reprint from the Report of the Board of Commissioners
of Agriculture and Forestry

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Division of Forestry

REPORT OF THE SUPERINTENDENT OF FORESTRY

Honolulu, Hawaii, December 31, 1920.

The Board of Commissioners of
Agriculture and Forestry,
Honolulu, Hawaii.

Gentlemen: I have the honor to submit as follows the report of the Division of Forestry for the calendar years 1919 and 1920.

INTRODUCTION.

As in past years, the work of this Division has naturally been along two main lines—forest protection and forest extension—and the details of work accomplished during the past two years in these two directions as well as in subsidiary activities are set forth in the following pages.

The chief value of the native Hawaiian forest, that of exerting a very beneficial influence on the run-off by preventing excessive floods and assuring a steady supply of water in springs, streams and artesian basins, has been explained many times in these and in other reports and is fairly well understood by all in this Territory, especially by those who are engaged in agricultural pursuits and are dependent on a sure and steady water supply. This principle, therefore, does not require further elucidation at this time.

The ways and means of maintaining and rehabilitating the native forest so that it will perform this function to its highest degree involve the problems which the Division of Forestry is working on and which are dealt with in this report.

Except for a few areas of private lands within forest reserve boundaries, which have, by provision of law, been turned over to the control of this Board for a term of years, the activities of this Division in the line of forest protection have necessarily and legally been confined entirely to lands within the reserves which are owned by the Territory. As a result of the peculiar system of Hawaiian land surveys, private lands are indiscriminately interspersed with government lands in the reserves. When it comes to the administration and protection of a reserve the work of this Division is thereby hampered and the result is unsatisfactory unless the owner of the private land cooperates to the fullest extent in the protection of his forest. An example of this failure to cooperate in forest protection occurs on Hawaii, where a large cattle ranch utilizes, as a pasture, a section of forest land within the recommended boundaries of the largest forest reserve on the island. Such a situation requires the construction and maintenance of fences which, in the mind of a forester, are entirely uncalled for and results in the destruction of the forest on the private land as the inevitable result of grazing.

Eventually, and the sooner the better, the title to all privately owned lands within the finally established boundaries of forest reserves should be acquired by the Territory so that situations, like the above-cited example, will be impossible and so that each reserve can be treated as a unit. In this manner only can the reserves be protected and administration facilitated with the most satisfactory results. To accomplish this, large appropriations will have to be made for acquiring the lands, and provision will have to be made by the Territory for an additional force of efficient men to manage them.

The Hawaiian Sugar Planters' Association is representative of the progressive cooperation which is possible in the care of the native forest. The forestry division of that association has made a good start in the proper direction by giving a section of the Kohala Mt. Forest Reserve on Hawaii better protection against the inroads of stock and by the establishment of two tree nurseries which are supplying trees for the reforestation of the open private lands in this reserve. The Division of Forestry is working in close cooperation with that association on this project. Similar cooperative work has already begun in connection with the Hilo Forest Reserve and the water producing reserves on Oahu.

FOREST PROBLEMS.

In the administration of the Hawaiian forest reserves as protection forests the immediate problems of the greatest magnitude which confront this Division consist of the adequate protection of the native forest against the inroads made by fire, man, invasive vegetation and stock and of the reforesting of denuded areas.

Under the first group, the fire menace fortunately is comparatively small, owing to the damp condition of the forest, which is maintained naturally except during unusually dry seasons. Intentional damage by man, such as timber trespass, is

Plate I.

Photo by Rock.

Moss-covered ohia lehua tree at Kilohana, Na Pali-Kona Forest Reserve, Kauai. Elevation 4,023 feet. Showing combination of trees and undergrowth ideal for the conservation of water.

practically negligible and is soon stopped because of the ease of apprehension. The carrying of seeds of undesirable and invasive vegetation, such as Hilo grass, into the mountains unconsciously by trampers, who are thus responsible for the insidious spread of such plants into the native forest with dire results, constitutes, however, a far more serious menace, as will be seen later on in this report.

The protection of the forest against inroads by stock is and will remain for some time the chief work of the Division. This is accomplished,'first, by the construction of new and the maintenance of existing fences on exposed boundaries to keep out stock, and, second, by the riddance of stock within fenced reserves. The susceptibility of the native forest, with its combination of shallow-rooted trees, undergrowth of ferns and vines, and ground cover of mosses and small plants (an ideal combination for preventing excessive run-off and converting surface drainage by percolation into sub-drainage) to damage by stock is so well known to all that it is unnecessary to repeat that one can not have a perfect native forest and stock on the same land. Grazing in the native forest simply starts the damage which is followed up by invasions of fast growing grasses, fungus and insect damage, and other attendant ills. The native forest, however, even when partially damaged in this manner, will recuperate to a large extent when given protection and it is well worth while to fence and keep out stock if there is a nucleus of native forest on the land. Nature works more rapidly than man by the process of natural tree reproduction and far more can be accomplished under most circumstances by protecting and giving the native forest a chance to rehabilitate itself than by the laborious and expensive process of artificial reforestation represented by tree planting.

Where land areas have been so completely deprived of their forest cover that natural reproduction can not be expected within a reasonable time the process of tree planting by human effort must be employed. This is especially true where forest denudation has been succeeded by the invasion of a fast growing ground cover, such as Hilo grass, which would greatly hinder the germination of naturally sown tree seeds. In this problem is involved the question of introducing, planting, and finally selecting (a long process) new species of vigorously growing trees which will produce a suitable forest cover, in combination with undergrowth, for water conservation and which will give quicker and better results than the shallow-rooted and susceptible indigenous species. The elimination of undesirable ground cover such as Hilo grass by shading out or by other means also comes in here for a share of attention. Experiments on this problem will be undertaken by this Division during 1921.

What the Division has done during the past two years toward the solution of these problems is shown in this report.

ADMINISTRATIVE FIELD FORCE.

At the beginning of the two-year period the Division had only seven forest rangers to look after the 557,344 acres of government forest land under its control, or one ranger for every 80,000 acres. At the end of the period eleven rangers were on the roster, or at the rate of one ranger for every 50,000 acres. The changes in the ranger force were as follows:

Ranger W. V. Hardy served on Kauai until June, 1920, when he resigned because of his departure from the Territory. The position has been left vacant until a qualified successor can be secured and an appropriation has been requested for such a man for the coming biennial period. Ranger Hosea K. Lovell is the other ranger on the windward side of Kauai.

On Oahu, Ranger Daniel Kapahu succeeded John Pililaau on February 1, 1919, as ranger for the Waianae District and on May 24, 1920, J. P. Pico was appointed honorary forest ranger for the Waianae-kai Reserve. On December 13, 1920, V. L. Ellis was appointed Forest Ranger at Large and will be assigned to duty on the other islands where needed as well as on Oahu. The other two rangers for this island are David Kapihi and E. H. Hipple.

On Maui, Ranger James Lindsay devotes almost his entire time to the Division's forest nursery at Haiku and another competent man for general ranger work is much needed for this island.

On Hawaii, Antone P. Aguiar was on April 14, 1919, appointed Forest Ranger to protect the forest on the Panaewa Reserve on the Volcano Road; on October 6, 1919, Charles E. Stone was appointed forest ranger for the reserves in Kau and South Kona; and on June 1, 1920, Harry L. Denison was appointed forest ranger to protect and administer the Kohala Mt. and Hamakua Pali Forest Reserves in cooperation with the Hawaii Sugar Planters' Association. The fourth ranger on Hawaii is A. J. W. Mackenzie. Another efficient ranger is much needed for the Hilo Reserve and unless an appropriation for this position is secured the plans made for the proper and very necessary protection of this reserve will unfortunately have to be abandoned.

During the early stages of changing the reserves from mere paper reserves to actual forest lands under administration it was necessary with the meager appropriations to limit the choice of rangers to local residents who had homes in the immediate vicinity of the reserves in their charge and who could devote a

Plate II.

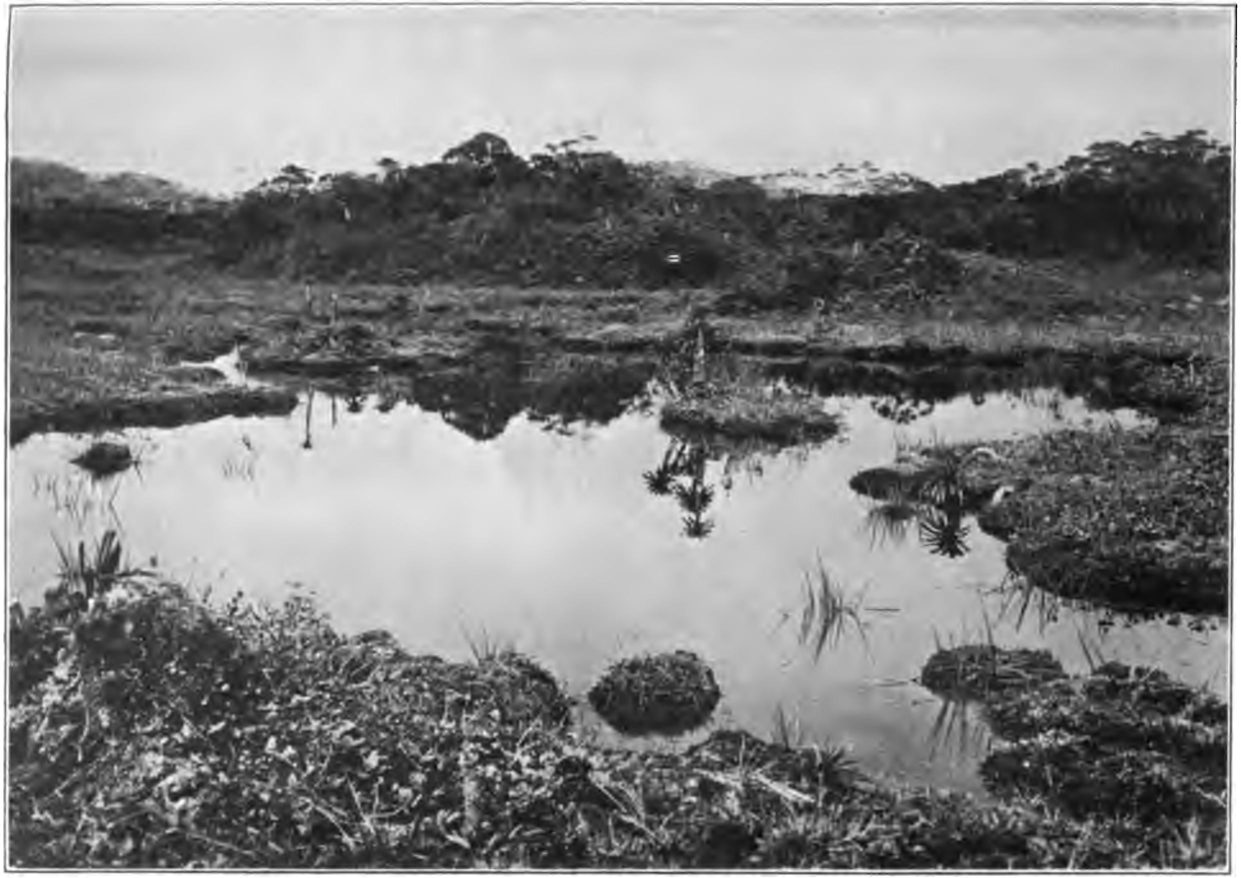

Photo by Rock.

Alakai Swamp, Na Pali-Kona Forest Reserve, Kauai. The source of many of the streams on the Garden Island.

part of their time to the general care of the land. The law requiring that only citizens can be employed also limited the choice of men to elderly Hawaiians or old white men because vigorous young citizens could not be secured for the salary offered. This condition obtains today to some extent, although the recent appointment of the Forest Ranger at Large, an energetic young man who devotes all of his time to the work is a step toward the end at which this Division is aiming, viz., the employment as forest rangers of energetic young citizens, preferably those who have had some technical forest training, who will devote all their time to the work and who will be furnished quarters at or near the forests where their work lies. The sooner adequate appropriations are made to carry this plan completely into effect the sooner will conditions on the forest reserves be whipped into proper shape.

A distinct addition to the staff was the appointment of Mr. Charles J. Kraebel, a graduate of the Michigan Forest School, veteran of the great war, and endowed with many years' experience with the U. S. Forest Service on the Pacific Coast. Mr. Kraebel began his duties in the Territory on June 23, 1920, and already has such a good grasp on the forest situation that much additional work, which had necessarily been delayed, has been accomplished by his personal efforts.

FOREST PROTECTION.

POLICY.

During the biennial period the Division established two policies on doubtful points which deserve mention here.

The first of these, established in August, 1919, is to treat the government lands in forest reserves throughout the Territory so that they will serve as sanctuaries for wild game of the feathered tribe where pheasants, chickens and other birds may breed and multiply unmolested. No permits to hunt birds on government lands in forest reserves have been issued, therefore, since the establishment of this policy and all such hunting is held as trespass. The only exception to this rule was made in October of the same year, when it was pointed out that the only place on Maui where the ordinary sportsman could hunt wild pheasants was in the Kula Forest Reserve and that an injustice was being done by the rule. Permits have been therefore issued for hunting pheasants on this reserve only during the open season. It is felt that the beneficial effects of this general policy will soon be felt by the natural increase of wild birds in the foothill country of the forest reserves.

The second was the stand taken in December, 1920, that, no matter how desirable it was to foster the new industry of making starch from tree ferns, no tree ferns would be allowed to be cut for this purpose on any government lands and that all permission for such a privilege would consistently be refused. This attitude was taken on well founded grounds because from careful observation it is apparent that no matter what care may be taken the removal of tree ferns would not only upset the delicate balance of nature found in the native forest, but would result in other attendant ills such as the opening up of the forest floor to the sunlight, the detrimental drying out of the shallow-rooted system of the trees, and the introduction of deleterious foreign grasses and weeds of an invasive nature. The native forest must be regarded as a valuable asset in itself when left alone and can not survive if it is to be exploited for starch or stock grazing.

FOREST RESERVE CHANGES.

No new reserves were proclaimed during the period, this work having already been accomplished in the main. Several changes were, however, made in existing reserves for purposes of releasing agricultural and park land, defining more appropriate boundaries, and perfecting certain exchanges.

On April 2, 1919, the Governor signed a proclamation withdrawing 415 acres of land along the edge of Waimea Canyon from the Puu Ka Pele Forest Reserve, Kauai, and subsequently issued an executive order turning the land over to the County of Kauai as a public recreational and camping park. The withdrawal of this area from the reserve for this purpose was approved by the Board on March 10, 1919, on application from the Kauai Chamber of Commerce, the Kauai Planters' Association, and the Kauai County Board of Supervisors. The area is situated on the brink of the famous and spectacular Waimea Canyon at an elevation of 3,500 feet and is accessible by automobile over a road which is soon to be improved. Water has been piped to the land, which will be opened to campers during the coming summer season.

The only other changes, five in number, were consummated by proclamations signed by Governor McCarthy on June 21, 1920. These were as follows:

1. The addition of 30,000 square feet of land along the Volcano Road, acquired by exchange from F. G. Snow, to Sec. C of the Olaa Forest Park Reserve, Hawaii.
2. The withdrawal of 83.10 acres of agricultural land from the Olaa Forest Reserve, Hawaii, near 24 Miles on the Volcano Road.
3. The withdrawal of 3,230 square feet of land on Tantalus

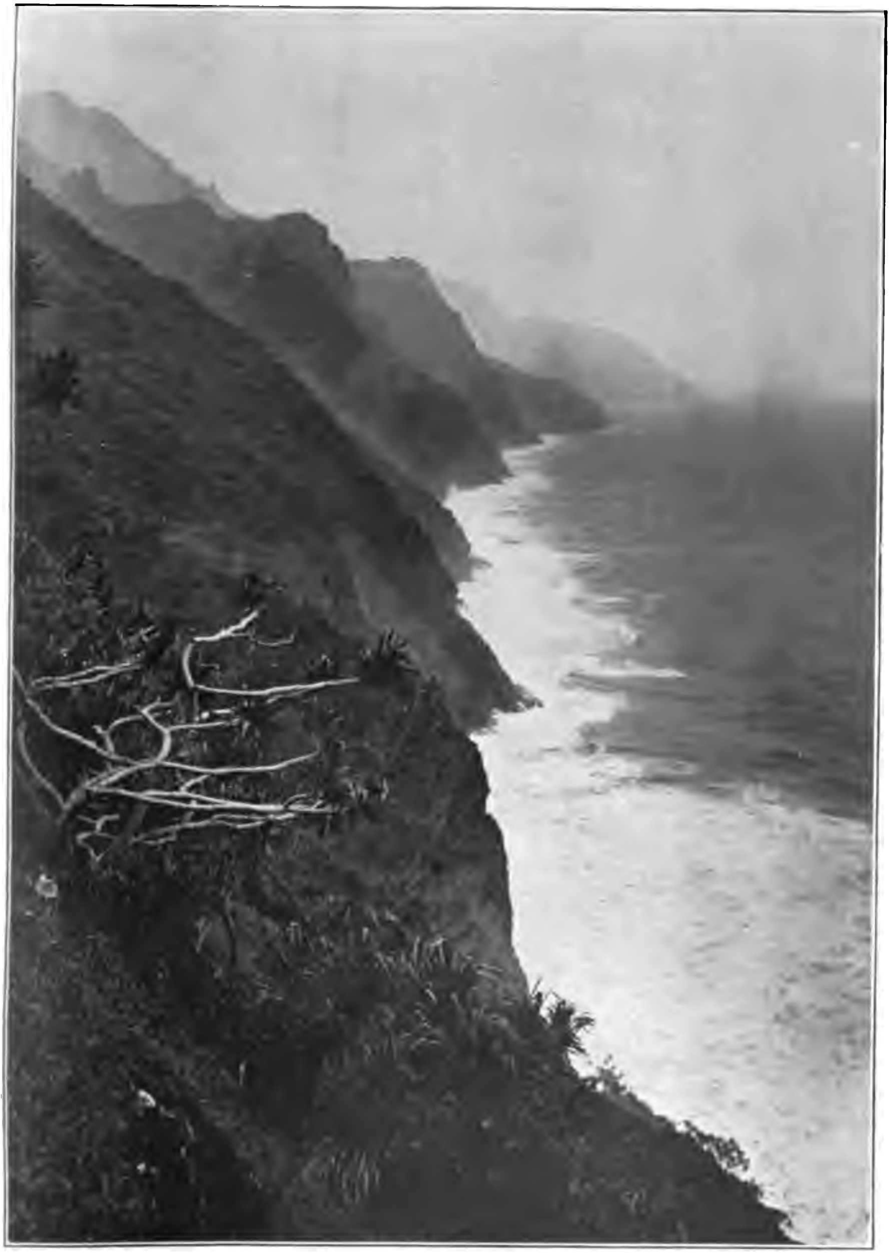

Photo by Rock.

The steep cliffs along the northwest coast of Kauai. Showing conditions in the Na Pali-Kona Forest Reserve. Native lauhala (Pandanus) trees growing almost to the water's edge.

Heights within the Honolulu Watershed Forest Reserve, Oahu, desired by the Land Commissioner for exchange purposes.

4. A modification of the lower boundary of the Lihue-Koloa Forest Reserve, Kauai, to release agricultural land and conform to an established fence line across the lands of Hanamaulu and Wailua, making a net reduction in area of 658 acres.

5. A modification of the boundaries of the Kealia Reserve, Kauai, to release agricultural land and make certain boundary lines more definite, making a net reduction in area of 885 acres.

With these changes, the present total area in the 47 forest reserves throughout the Territory now amounts to 817,114 acres, which is about 20 per cent of the total land area of all the islands. As will be seen in the following table, only 68 per cent of the land in forest reserves, or 557,344 acres, belongs to the Territory.

SUMMARY OF FOREST RESERVE AREAS.

Island	Number of Reserves	Private Acres	Government Acres	Total Acres	Per Cent
Kauai	8	66,574	80,096	146,670	18%
Oahu	15	33,888	34,045	67,933	8%
Molokai	1	31,406	13,268	44,674	6%
Maui	7	46,148	74,980	121,128	15%
Hawaii	16	81,754	354,955	436,709	53%
Totals	47	259,770	557,344	817,114	100%
Per Cent		32%	68%	100%	

The problem of inspecting, fencing, planting, and otherwise managing more than half a million acres of government forest land located in mountainous country and scattered over five different islands, the furthermost 360 miles apart, is not as simple as if the areas were located in one compact accessible body.

Although the main bulk of forest reserve land has been set aside, there remain a few additional areas to be created. One of these is the forest land along the cliffs of Waimanalo and Kailua on Oahu, which will soon be reported on. It is planned also to add more forest land to the Hilo Reserve on Hawaii as soon as the survey can be made. It is most desirable also to secure and add to the Kohala Mt. Reserve on Hawaii an area of over 4,000 acres of land on an important watershed which is being denuded of its forest by grazing.

The following table gives the acreage of each reserve and at the end of this report there is set forth in detail the name and acreage of each land in each forest reserve in the Territory.

LIST OF FOREST RESERVES, TERRITORY OF HAWAII.

January 1, 1921.

Name of Reserve	No.	Private Land, Acres	Government Land, Acres	Total Area Recommended to be Reserved, Acres	Date of Proclamation
		ISLAND OF KAUAI.			
Halelea	5	26,510	10,990	37,500	Aug. 24, 1914
Kealia	6	2,470	6,580	9,050	Mar. 9, 1906
Na Pali-Kona	13	19,890	40,650	60,540	June 12, 1907
Lihue-Koloa	19	15,661	12,941	28,602	June 5, 1909
Moloaa	20	2,043	3,578	5,621	June 5, 1909
Papapaholahola	41	.....	54	54	June 19, 1918
Nonou	44	.....	818	818	Dec. 31, 1918
Puu Ka Pele	45	.....	4,485	4,485	Dec. 31, 1918
		66,574	80,096	146,670	
		ISLAND OF OAHU.			
Kaipapau	1	.....	913	913	Nov. 10, 1904
Ewa	7	23,399	5,151	28,550	Mar. 9, 1906
Waianae-kai	10	107	3,546	3,653	Sept. 7, 1906
Lualualei	11	.....	3,743	3,743	Nov. 30, 1906
Pupukea	21	.....	864	864	May 10, 1910
Nanakuli	28	.....	1,010	1,010	June 4, 1913
Makua-Keaau	29	340	4,480	4,820	June 4, 1913
Kuaokala	30	.....	434	434	June 4, 1913
Honolulu Watershed	34	1,952	4,998	6,950	Oct. 13, 1913
Kuliouou	35	.....	214	214	Feb. 13, 1913
Manoa Ranger Station	38	.....	15	15	May 9, 1916
Round Top	39	.....	115	115	Aug. 10, 1916
Waiahole	42	40	1,129	1,169	June 19, 1918
Mokuleia	46	.....	6,290	6,290	Dec. 31, 1918
Hauula	47	8,050	1,143	9,193	Dec. 31, 1918
		33,888	34,045	67,933	

		ISLAND OF MOLOKAI.			
Molokai	26	31,406	13,268	44,674	Sept. 11, 1912
		ISLAND OF MAUI.			
Koolau	4	12,739	30,230	42,969	Aug. 24, 1905
Hana	12	1,058	13,767	14,825	Nov. 30, 1906
West Maui	14	25,335	19,147	44,482	Apr. 21, 1908
Makawao	15	.....	2,093	2,093	Apr. 21, 1908
Waihou Spring	18	10	74	84	June 5, 1909
Kula	27	1,006	5,069	6,075	Sept. 11, 1912
Kipahulu	36	6,000	4,600	10,600	Aug. 20, 1914
		46,148	74,980	121,128	
		ISLAND OF HAWAII.			
Hamakua Pali	2	2,607	16,333	18,940	Dec. 23, 1904
Hilo	3	49,777	60,223	110,000	July 24, 1905
Honuaula	8	.....	665	665	Apr. 4, 1906
Kau	9	6,255	60,839	67,094	Aug. 2, 1906
Waiaha Spring	16	.....	193	193	Apr. 21, 1908
Mauna Kea	17	.....	66,600	66,600	June 5, 1909
Hauola	22	.....	7	7	June 13, 1910
South Kona	24	7,692	29,260	36,952	May 17, 1911
Puna	25	.....	19,850	19,850	June 29, 1911
Kohala Mt.	31	15,423	14,204	29,627	Oct. 13, 1913
Upper Waiakea	32	.....	55,000	55,000	Oct. 13, 1913
Upper Olaa	33	.....	9,280	9,280	Oct. 13, 1913
Olaa Forest Park	37	.....	532	532	Aug. 20, 1914
Panaewa	40	.....	1,750	1,750	Apr. 11, 1917
Keauohana	43	.....	272	272	June 19, 1918
Olaa	48	.....	19,947	19,947	Dec. 31, 1918
		81,754	354,955	436,709	
TOTAL ALL ISLANDS		259,770 32%	557,344 68%	817,114 100%	

RULES AND REGULATIONS.

The present rules and regulations for the protection and administration of government lands in the forest reserves have worked out well and have proven so satisfactory that it has not been necessary to make any changes in them during the period under review.

In March, 1919, two Orientals were arrested in Wood Valley, Kau, Hawaii, for violating paragraph (b) of Rule II by allowing livestock to graze in the Kau Forest Reserve. Each was given a suspended sentence of 13 months by the district magistrate. In October of the same year two Orientals were arrested for cutting grass within the area around the reservoirs in Nuuanu Valley on Oahu on which trespass is prohibited by Rule III. They pleaded guilty in the Honolulu police court and were given suspended sentences of 13 months.

PROPOSED RULE V.

The alarming rate at which Hilo grass is spreading along cut trails in the mountains of Oahu, due to the seed being carried into the native forest on the trousers and shoes of trampers, and the trepidation with which I view the disastrous results to the undergrowth and eventually to the native trees, more particularly on the steep watershed areas immediately back of Honolulu, led me early in February, 1920, to prepare Rule V, which contemplates the exclusion of the public from the native forest on the steep mountain slopes at the head of Palolo and Manoa Valleys.

The retention of the native forest growth and its preservation in the healthiest possible condition on this area is of the utmost importance for the perpetuation of the streams and springs arising thereon and contributing to the water supply of Honolulu, and I consider it of the utmost importance to give this forest the greatest protection possible. It will be far cheaper to stop the damage now rather than to try to reforest the area at prohibitive cost after the growth has been destroyed by the further spread of this invasive grass.

The excluding of persons from the area, thereby stopping the further importation of Hilo grass seed, is the necessary first step toward eliminating the grass from the trail and adjacent areas to which it has spread. Unless trampers are kept off the trail and the entire area it will be useless even to start this control work.

This proposed rule has received the hearty endorsement of the Hawaiian Sugar Planters' Association and, that it might be discussed before adoption, a public hearing was on June 9, 1920,

Plate IV.

Photo by Kraebel.

Water and dense forest growth along Kalakaoo stream above Akaka Falls, Kaiwiki, in the Hilo Forest Reserve, Hawaii.

held on the subject. This hearing was well attended and the grave danger of the ruination of the native forest by the spread of Hilo grass brought in, in seed form, and scattered along the trail by the feet of trampers was pointed out by forest experts. Opposed to this were the arguments that the Olympus-Konahuanui trail should be kept open as a tourist asset and for the use of local recreationists.

Rule V was presented to you for consideration in a special report dated April 19, 1920, and its adoption was again strongly recommended to you in my routine report for June, 1920. It is at this time called again to your attention, and I respectfully urge its adoption so that the control work can be initiated before the task becomes too herculean.

FOREST FENCING.

The task of protecting forest boundaries exposed to stock by the construction of fences has progressed almost as rapidly during the period as in the previous two years. Since in most cases a personal examination of the proper line to be fenced must first be made and detailed arrangements perfected for hauling material and supplying labor, and owing to the widely-scattered and comparatively inaccessible locations of fencing projects and the necessity often of determining on the right line by a survey, the fencing problem is not the simple one that might be imagined in which rapid progress can be made. The necessity of turning my attention early in 1920 to the insect control work in Olaa, Hawaii, and later on in the year an enforced leave of absence due to ill health interfered greatly with the fencing program that I had laid out. In spite of this, the Division has on its own initiative, and in cooperation with private owners and the Land Office, effected the construction of 10.79 miles of new fencing and the repairing of 5.27 miles of existing fences on exposed forest reserve boundaries during the past two years, making a total of 16.06 miles of boundary receiving proper protection, as shown in the tables which follow. This brings the fencing work up to 74.17 miles during the past 10 years.

There are about 17 miles of reserve boundaries in immediate need of fencing, and it is earnestly hoped that the Legislature will appropriate sufficient funds to accomplish this most important work during the coming biennial period.

FENCES CONSTRUCTED, 1919-1920.

Date Completed.	Island.	Reserve.	Location.	Length (Miles).
Feb., 1919	Hawaii	Kau	Kiolakaa	1.00
Mar., 1919	Oahu	Makua-Keaau	Keaau	.84
Mar., 1919	Oahu	Makua-Keaau	Makua	1.07
June, 1919	Hawaii	Kohala Mt.	Pololou	.13
July, 1919	Hawaii	Olaa Forest Park	Sec. C	.30
Aug., 1919	Hawaii	Olaa Forest Park	Sec. A	.19
Sept., 1919	Maui	Kula	Papaanui	2.68
Oct., 1919	Hawaii	Olaa Forest Park	Sec. C	.28
Dec., 1919	Maui	Kula	Waiohuli	1.40
Jan., 1920	Oahu	Kuliouou	Valley	.40
Sept., 1920	Hawaii	Olaa Forest Park	Sec. C	.25
Nov., 1920	Hawaii	Kau	Kaalaiki	.61
Dec., 1920	Hawaii	Olaa Forest Park	Sec. C	1.64
Total				10.79

FENCES REPAIRED, 1919-1920.

Date Completed.	Island.	Reserve.	Location.	Length (Miles).
Feb., 1919	Kauai	Moloaa	Moloaa	3.00
Oct., 1919	Kauai	Papapaholahola	Papapaholahola	.38
Jan., 1920	Oahu	Kuliouou	Valley	.71
Jan., 1920	Oahu	Kuliouou	Maunalua	.71
Dec., 1920	Oahu	Waianae-kai	Homesteads	.47
Total				5.27

REMOVAL OF STOCK FROM RESERVES.

Following the fencing of reserve boundaries comes the important work of ridding the forest of stock within the fenced areas. Permits to hunt wild quadrupeds in the reserve have been freely issued to responsible parties. Reports from these, which are by no means complete, show that during the past two years 384 wild goats, 55 wild cattle, and 435 wild pigs, a total of 874 wild animals, have been killed on forest reserves.

In cooperation with ranchers and plantations cattle which were tractable have been driven out of reserves. At the present time, tame cattle getting into reserves either accidentally through broken places or by the malicious design or the negligence of the owners, constitutes a greater nuisance and results in greater damage to the reserves than that caused by wild cattle. To strengthen the position of the Division of Forestry in carrying out this important feature of forest protection it is desirable to amend the present law (second sentence in Sub-section 9 of Section 481, R. L. H. 1915) by substituting the following:

"After a forest reservation, duly set apart and established, has been completely fenced, and after thirty days' public notice,

Plate V.

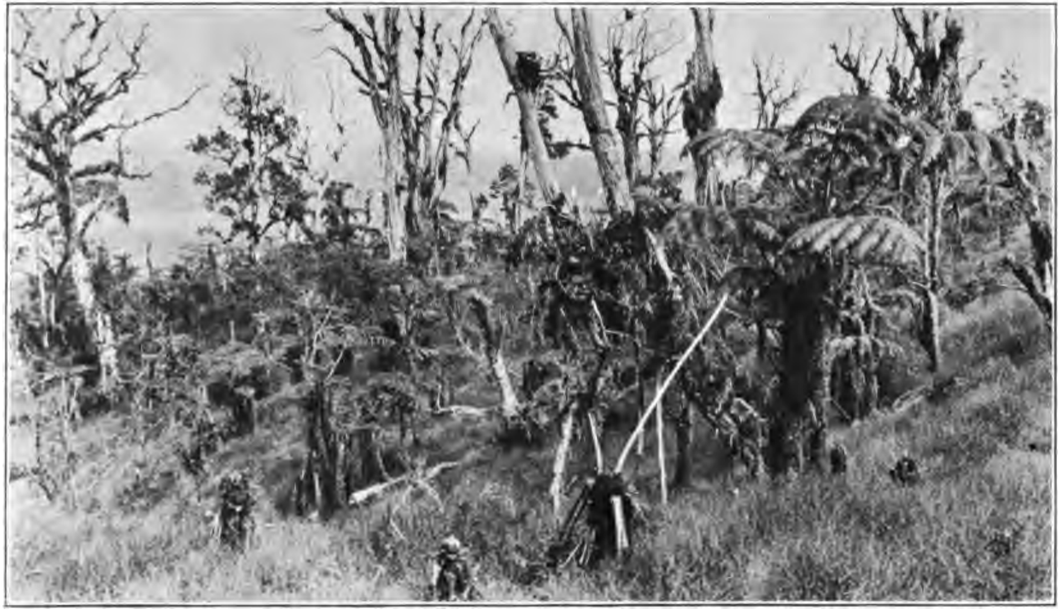

Photo by Kraebel.

Leased land below the Hilo Forest Reserve, Honomu, Hawaii. Showing forest destruction due to cattle grazing followed up by invasion of Hilo grass.

five insertions, of such accomplishment has been given by publication in a newspaper of general circulation in the county or city and county where such reservation is situated, the owner or lessee of land in such reservation, if such land be privately-owned and the agents of the board of agriculture and forestry in all cases where the land is so set apart and established as a forest reservation, whether from privately-owned lands or public lands, may without further notice remove, shoot, or destroy any and all cattle of any description found on any such forest land in the Territory without compensation to the owner."

This is made urgent by a recent opinion from the Attorney General (No. 950) in which he holds (1) that a violation of a regulation of this Board constitutes a criminal offense and to secure a conviction therefor all the elements of a criminal offense, including that of guilty knowledge or willfulness, must be shown and (2) that this Board is without authority to impose by regulation a penalty in the nature of liquidated damages for trespass by cattle on forest reserves.

FOREST FIRES.

During the biennial period there have been perhaps more fires than usual, due to the two comparatively dry years, but none of them fortunately did any considerable or extensive damage to native forest growth. The following fires were reported:

FERBUARY 27, 1919: Ohikea section of Kapapala Ranch, Kau, Hawaii. Fire of unknown origin burned over 1,500 acres of mostly grass land, but was extinguished the same day by ranch cowboys and laborers from Pahala Plantation under Fire Warden James Campsie.

FEBRUARY 29, 1919: Wailau, at the edge of the Kau Forest Reserve, Hawaii. A fire of unknown origin burned over 40 acres of forest land with considerable damage to undergrowth and a quantity of ohia trees. Men under Fire Wardens George Gibb and James Campsie soon extinguished it.

MAY 6, 1919: Pupukea Forest Reserve, Oahu. During some pineapple clearing operations a fire jumped the fire guard and burned over 40 acres of grass, damaging a few clumps of trees. Laborers working under Fire Warden F. S. Lyman extinguished it the same night.

JULY 6, 1919: Lihue, Honouliuli, Oahu. A bee-hive thief set fire to the grass with his smoking torch. The fire spread over 75 acres of grassland with practically no damage to trees. It was extinguished the same day by soldiers and laborers under Mr. A. W. Eames and Fire Warden A. A. Wilson.

JULY 6, 1919: A fire started on this day, presumably by pig hunters, burned over about 5,500 acres of pasture land in

Kaohe and Kaholalele, on the slopes of Mauna Kea, Hamakua, Hawaii, at an elevation of 5,000 to 7,000 feet. In spite of all efforts it continued to burn for approximately two months before it was extinguished by rains.

August, 1919: During this month two small fires, less than one acre each in extent, and which caused practically no damage, were extinguished almost at once by Ranger Hardy in the Na Pali-Kona Reserve, Kauai.

October 1, 1919: A grass fire on the ridge in Nuuanu Valley adjacent to the Country Club, started by brush burners, swept over an area of 20 acres of grass and brush land on the slope, but was extinguished in three hours by the fire department and men working under Deputy Fire Warden Haughs.

November 9, 1919: Wainiha, Kauai. A fire started along the ditch trail burned over an area of staghorn fern, but was soon extinguished by men under Fire Warden A. Menefoglio.

January 25, 1920: Halawa, Oahu. A fire of unknown origin burned over 25 acres of steep open grass land on the ridge, but stopped the same night as soon as it reached the damper vegetation.

February 12, 1920: Pololou Gulch, Kohala Mt. Reserve, Hawaii. A fire was started by a small boy in the gulch bottom and the wind carried it up the west side of the gulch through the underbrush. Laborers under the direction of Manager J. A. McLennan promptly rushed to the scene and, fighting the fire from 8 a. m. to 4 p. m., succeeded in extinguishing it before it had done any considerable damage.

May 1, 1920: Woodlawn, Manoa Valley, Oahu. A fire started to clear land for the planting of pineapples jumped the fire guard at 3 p. m. and burned over about 10 acres of grass and ferns on a hillside. It was extinguished in 2½ hours by local men and officers from the Government Nursery.

May 11, 1920: Waiakea, Hawaii. A fire started from a cane trash fire and burned over about 300 acres of grass, brush, and young ohia trees on private land on the 1880 flow near Hilo. Very little of the old forest was touched, and it was extinguished the next day by men working under Fire Warden James Henderson and Ranger Mackenzie.

May 27, 1920: Koolau Forest Reserve, Maui. The first fire in 16 years in this wet forest started at 3:30 p. m. at Nahiku between Kapaula and Waiohue gulches, but was put under control by 7 p. m. the same day by men working under Fire Warden W. F. Pogue. Above the ditch it burned over 20 acres of forest in the reserve and below the ditch and outside of the reserve it burned over 175 acres.

June 9, 1920: Olaa, Hawaii. A surface fire spread rap-

Plate VI.

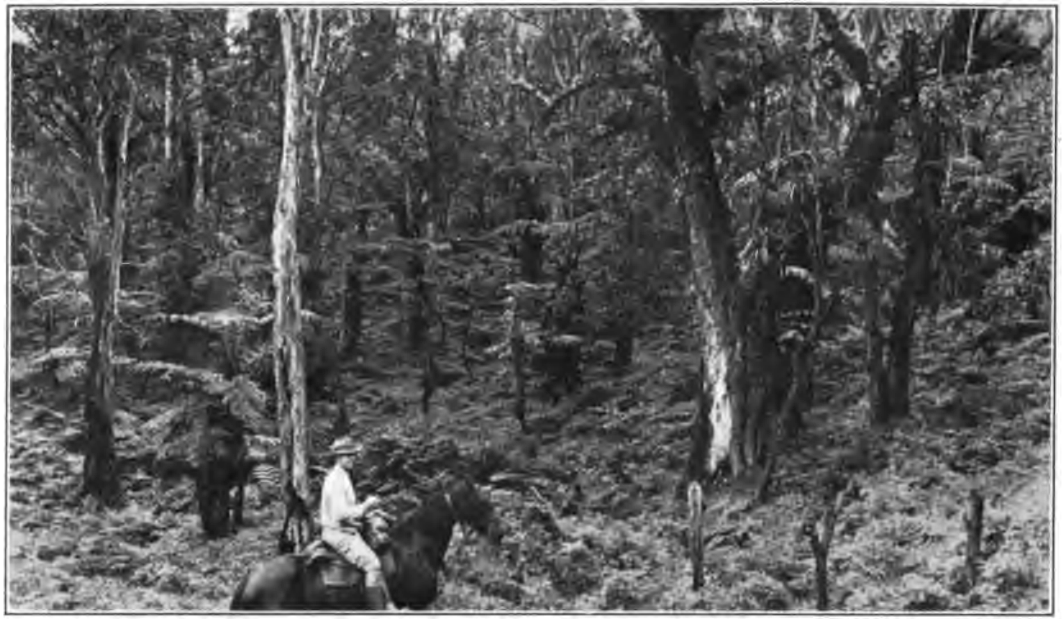

Photo by Kraebel.

Luxuriant growth of trees and ferns on the protected government land of Laupahoehoe within the Hilo Forest Reserve, Hawaii. The adjacent grazing land absolutely lacks such growth.

idly over about 100 acres of private brush land in the region from 22 to 24 Miles near the Volcano Road, but was placed under control the same day by men working with Forest Ranger Mackenzie.

The voluntary District Fire Wardens appointed by the Board have rendered efficient and prompt service to the Territory and I wish here to express to them my appreciation of their faithful performance of duty in carrying out the forest fire laws. A number of new Fire Wardens were appointed during the period to replace those who had died, resigned or moved away.

A revised list of District Fire Wardens, and of honorary District Foresters and Forest Rangers, is presented at the end of this report.

FOREST EXTENSION.

BOTANY.

Mr. J. F. Rock, as Consulting Botanist, continued to render the Division valuable services by contributing two botanical bulletins, Nos. 5 and 6, which have been published and issued by the Division; an article on the poisonous plants of Hawaii, which appeared in the March and April 1920 "Forester," and a manuscript containing a revised list of Hawaiian names of plants (soon to be published) and by securing seed of new and valuable ornamental and forest trees from tropical countries for propagation by this Division.

Among the seed importations made by Mr. J. F. Rock was a consignment of 7 pounds of seed of one of the chaulmoogra oil trees, *Hydnocarpus anthelminticus,* received from Siam on November 27, 1920. The young seedlings resulting from this shipment are coming along nicely and when ready will be planted out in favorable places for the express purpose of supplying seed for the production of the oil which, when refined by the Dean process, will be used locally for the cure of leprosy.

For the purpose of record, mention is made here of the discovery by the Superintendent of Forestry on January 23, 1919, at Keaau, Oahu, at an elevation of 950 feet above the sea, of the mamani tree, *Sophora chrysophylla.* Small trees of these species were in both flower and fruit, which made the identification positive. So far as it is known, this is the first time that the mamani has been found on Oahu.

A working herbarium of specimens of native trees has been started by the Division of Forestry and will be added to as opportunity affords, so as to enable the staff to become better acquainted with our forest flora. Seeds of the native species and especially the rare ones such as the native red cotton, *Kokia Rockii Kauaiensis,* are also collected on field trips so as to determine their ease of propagation, rate of growth, and adaptability for use in reforestation projects.

Seedling trees are now being assembled for use in planting out in the Makiki Valleys with the idea of establishing there, if a sufficient appropriation for labor is made, an accessible arboretum of classified and labelled trees, amounting to several thousand different kinds, from all tropical parts of the globe, which will in time serve as a living reference library for botanists and will be the wonder and admiration of visiting tourists and scientists.

TREE INTRODUCTION.

The importation of seed of new species from the other parts of the tropical world has been continued during the period, and the resulting seedlings when ready have been planted out in a variety of situations to determine their usefulness in our reforestation work in the solution of the great problem of reclothing with a forest growth areas which have been so badly denuded that they will not come back naturally to native species.

Cooperation has been rendered the Hawaiian Sugar Planters' Association in its project of securing and introducing fertilizing wasps so as to make possible the local production of fertile seed on our *Ficus* trees by sending the Board's Entomologist to Hong Kong and India.

The forestry division of the Hawaiian Sugar Planters' Association has also been quite active in the importation of seed of new species and has propagated a large variety of trees which are new to this Territory and which will be planted out in various situations with the same object in view. These two divisions have been working in close cooperation on these lines and have made frequent interchanges of seeds and seedlings.

The beneficial results of tree introduction to overcome the difficulty of securing supplies of seed have been obtained in the case of two valuable trees from specimens of which now growing in these Islands we are able to secure fresh seed and are therefore independent of importations. One of these, the Australian red cedar, *Cedrela australis,* a valuable timber tree introduced from Australia in 1914, began to produce abundant supplies of fertile seed in the summer of 1919. The other is the African tulip tree, *Spathodea campanulata,* a popular and handsome ornamental tree introduced from Madagascar on April 15, 1916, which in August, 1920, only four years after planting, is now producing good seed on a large number of individual trees.

In the efforts to disseminate seedlings of the valuable kauri pine, *Agathis australis,* throughout the Territory for the produc-

Plate VII.

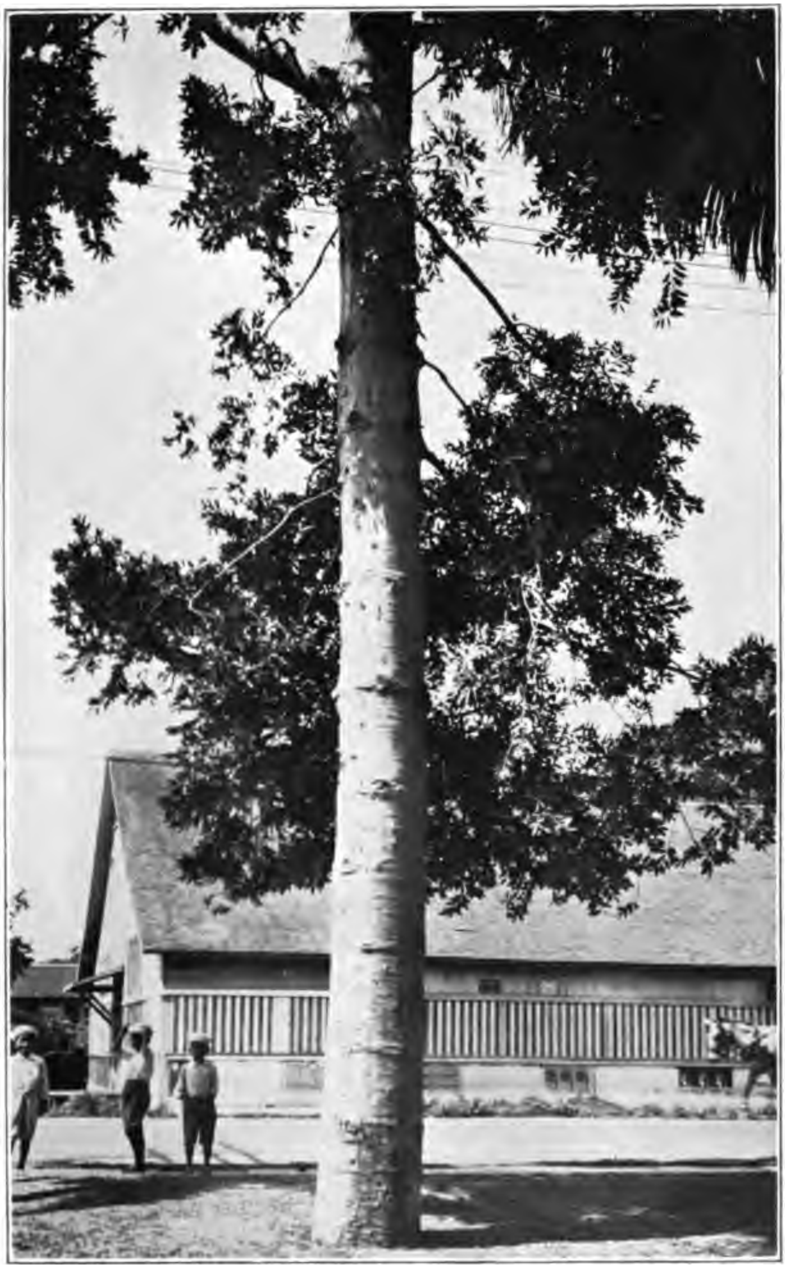

Photo by Judd.

Kauri pine (Agathis australis) at the Government Nursery, Honolulu. Age 35 years. Height 66 feet. Diameter 25 inches.

tion of timber, two shipments of seed of this conifer were obtained through the efforts of Mr. Adolph Moritzson from Mr. E. Phillips Turner, Secretary of the Department of Forestry at Wellington, New Zealand. The germination of the several pounds of seed planted resulted in almost complete failure and only two seedlings were produced. It would seem, therefore, that for the propagation of this desirable timber tree we must depend upon the crop of seeds produced only at intervals by the mature trees already in these Islands.

During the latter part of December in the years 1919 and 1920, the Division was able to gladden the hearts of many children by supplying Christmas trees cut from a plantation of Japanese cedar, *Cryptomeria Japonica,* planted out in Makiki Valley in December, 1917, with this very object in view.

All sympathetic Honolulu residents were very sorry to see the original algaroba tree, *Prosopis juliflora,* in the Catholic Cathedral grounds on Fort street, Honolulu, cut down on October 23, 1919, to make room for the new Knights of Columbus building. Imported in 1828, this parent tree had stood there for 91 years as an object of historical interest and a monument to Father Bachelot, who introduced it. Perhaps no other tree the world over has been responsible for greater benefits than this original algaroba, for from it, by the distributing agency, mainly of stock, there has been established on the lee shores throughout these Islands extensive forests which now cover approximately 90,000 acres of what used to be barren land, but which by reason of this tree now produce an annual crop of about 30,000 cords of exceedingly valuable fuel wood, over $160,000 worth of honey, and an enormous yield of beans which furnish a valuable fattening food for stock at a time when the long, dry summer has exhausted the grass supply.

TREE PROPAGATION AND DISTRIBUTION.

The Division of Forestry has now in active operation seven tree nurseries on the four main islands, as follows:

1. Kalaheo Nursery, Kauai, in charge of Joe Rita, Jr.
2. Government Nursery, Honolulu, Oahu, in charge of David Haughs.
3. Makiki Nursery, Honolulu, Oahu, in charge of David Haughs.
4. Waiahole Nursery, Koolaupopo, Oahu, in charge of Alfred Rocha.
5. Mikilua Nursery, Waianae, Oahu, in charge of J. K. Luka.
6. Haiku Nursery, Maui, in charge of James Lindsay.
7. Hilo Nursery, Hawaii, in charge of Bro. Matthias Newell.

The nurseries numbered 4 and 5 are devoted to the production of trees for the exclusive use of planting on forest reserves, while all of the others produce trees for this purpose and for supplying the demands of homesteaders, agriculturists, army posts, ranches, and plantations throughout the Territory for forest, shade, fruit and ornamental trees and vines and shrubs.

Cognizant of the danger of disseminating insect pests to the other islands by shipping plants in soil, this Division early in 1919 voluntarily discontinued this practice. This was followed by the passing on June 1, 1919, of Rule XX of the Division of Plant Inspection, which prohibited the shipping of plants in soil from Oahu to the other islands except in very unusual cases. Hitherto, the demand for trees on the other islands was largely supplied from the Honolulu nurseries, and in order to meet this demand locally a new nursery was established in June, 1919, at Haiku, Maui, and the nursery in Hilo relocated and enlarged in the fall of 1920.

There were distributed from the nurseries, as will be seen in the report of the Forest Nurseryman, a total of 292,081 trees in 1919 and 223,966 trees in 1920, or a total of 516,047 during the two years. This is 135,364 trees less than during 1917 and 1918, but this difference can well be accounted for by the strike which made labor scarce and expensive and the two dry years which made conditions unfavorable for tree planting.

ARBOR DAY.

Arbor Day, as in previous years, was designated by proclamation of the Governor and celebrated by appropriate exercises and tree planting mostly by school children on November 21 in 1919 and on November 19 in 1920.

The number of trees distributed from the government nurseries for planting on Arbor Day during the last two years was as follows:

Nurseries.	1919.	1920.	Total.
Kalaheo Nursery, Kauai	....	200	200
Government Nursery, Honolulu	6,292	4,370	10,662
Haiku Nursery, Maui	....	920	920
Hilo Nursery, Hawaii	....	1,215	1,215
Totals	6,292	6,705	12,997

On the 1919 Arbor Day, 1,390 children, and on the 1920 Arbor Day, 1,732 children of a number of different races called in person at the Government Nursery and were given one tree each for planting.

Plate VIII.

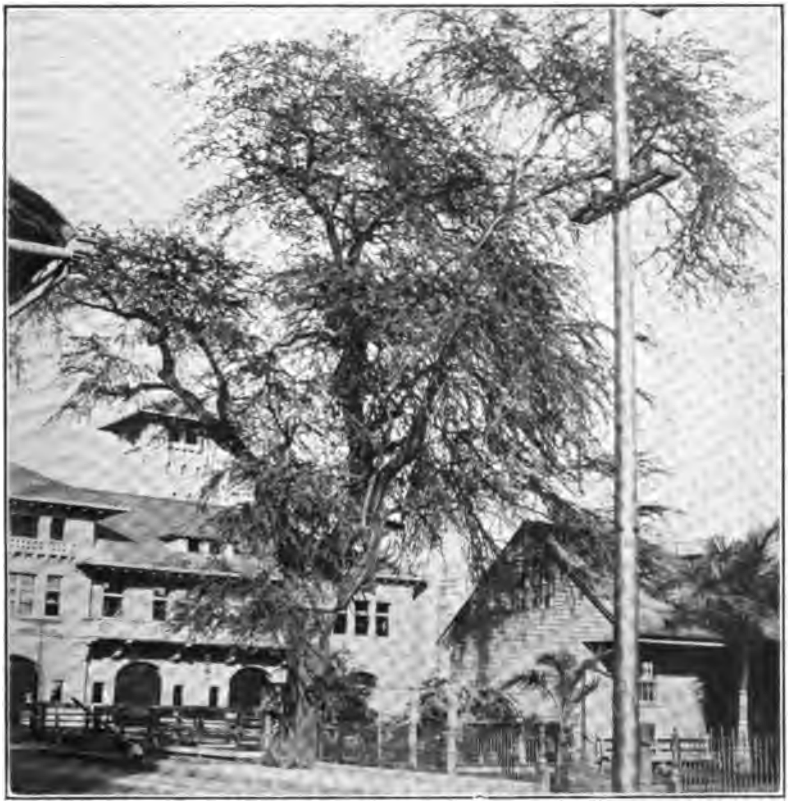

Photo by Hosmer.

The original algaroba tree in Hawaii, now gone.

TREE PLANTING ON FOREST RESERVES.

By the efforts of this Division there were planted out during the two-year period almost twice the number of trees that was planted in the previous biennium. A total of 71,641 trees of 37 different species was set out on 11 different forest reserves on Kauai, Oahu, and Maui. From the list which follows it will be seen that an attempt has been made to start a great variety of trees in a number of places in order to determine the ones best suited to different localities so that attention can be centered on these in future plantings.

Trees Planted in Forest Reserves in 1919 and 1920.

Red gum (*Eucalyptus rostrata*)	13,843
Koa (*Acacia koa*)	12,573
Australian red cedar (*Cedrela australis*)	10,351
Red mahogany (*Eucalyptus resinifera*)	8,707
Yellow poinciana (*Peltophorum inerme*)	4,737
Ironwood (*Casuarina equisetifolia*)	3,537
Bloodwood (*Eucalyptus corymbosa*)	2,984
Ironbark (*Eucalyptus crebra*)	2,713
Swamp mahogany (*Eucalyptus robusta*)	1,844
Silk oak (*Grevillea robusta*)	1,842
Johore fig (*Ficus sp.*)	1,842
Monkey-pod (*Samanea saman*)	1,292
Cook pine (*Araucaria Cookii*)	1,062
Logwood (*Haematoxylum campechianum*)	757
Kauri pine (*Agathis australis*)	640
Mahogany (*Swietenia Mahogani*)	579
Molave (*Vitex parviflora*)	330
Japanese cedar (*Cryptomeria Japonica*)	310
Khair tree (*Acacia catechu*)	247
Kassod (*Cassia siamea*)	220
Mountain albizzia (*Albizzia montana*)	212
Sappan (*Caesalpinia sappan*)	180
Wiliwili (*Erythrina monosperma*)	170
Tall fig (*Ficus altissima*)	141
Blackwood (*Acacia melanoxylon*)	100
Banyan (*Ficus retusa intida*)	88
Lime (*Citrus medica acida*)	85
Peepul tree (*Ficus religiosa*)	50
Chinese banyan (*Ficus retusa*)	50
Narra (*Pterocarpus indicus*)	37
Wood-oil tree (*Aleurites Fordii*)	35
Red sandalwood (*Adenanthera pavonina*)	27
Camphor (*Cinnamomum camphora*)	25

Aralia (*Brassaia actinophylla*)	17
Arabian teak (*Cordia amplifolia*)	14
Naio, bastard sandalwood (*Myoporum Sandwicense*)	7
Rimu, red pine (*Dacrydium cupressinum*)	2
Total	71,641

On Kauai, swamp mahogany and silver oak were planted on the Kealia Reserve, and at the Papapaholahola Spring Reserve, swamp mahogany, ironwood, and Australian blackwood trees were set out.

On Oahu the planting of koa trees has been continued on the Honolulu Watershed in the Makiki Valleys, and this species has been found so far to take hold on the well-drained slopes here and in Manoa Valley and to grow faster and form a better cover than any introduced species. In a protected pocket back of Sugar Loaf 835 Australian red cedar trees were set out in June and July, 1920, to determine their growth and behavior at that elevation.

The largest plantings have been made at Mikilua, Waianae, in the Lualualei Forest Reserve, Oahu, where a gang of seven Hawaiian tree planters have set out during the two years 57,512 trees of 22 different species in the effort to strike on a number of trees best suited to the region. At the summit of Kolekole Pass the native koa has been planted and is growing well. On the middle slopes a variety of trees such as monkeypod, yellow poinciana, kassod, silk oak, sappan, ironwood, banyans, Australian red cedar, and Cook pine have been used with success, and on the lower dry foothills the drought-resisting khair, logwood, and wiliwili and the more valuable eucalyptus such as red gum, bloodwood, red mahogany, and ironbark have been planted. The results of the planting in this region, which has now been going on for only 2½ years, are already making a marked change in the landscape, and I am confident that the beneficial effect of this planted forest on a more continued and steady supply of water in Mikilua Valley will be apparent in a few years.

A row of highland ironwood trees was set out inside of the new forest reserve fence in Keaau Valley, Waianae, in March, 1919, and 555 red gum trees were similarly planted along the new fence in Kuliouou Valley in February, 1920.

At Waiahole, Oahu, 2,764 trees of 17 different varieties have been planted out during the period on a fenced portion of the forest reserve by the only faithful day laborer who could be secured in the district. Among the species which are growing well here are the molave and narra from the Philippines, Arabian teak, the native bastard sandalwood (*Naio*), Cook pine, Japan-

Plate IX.

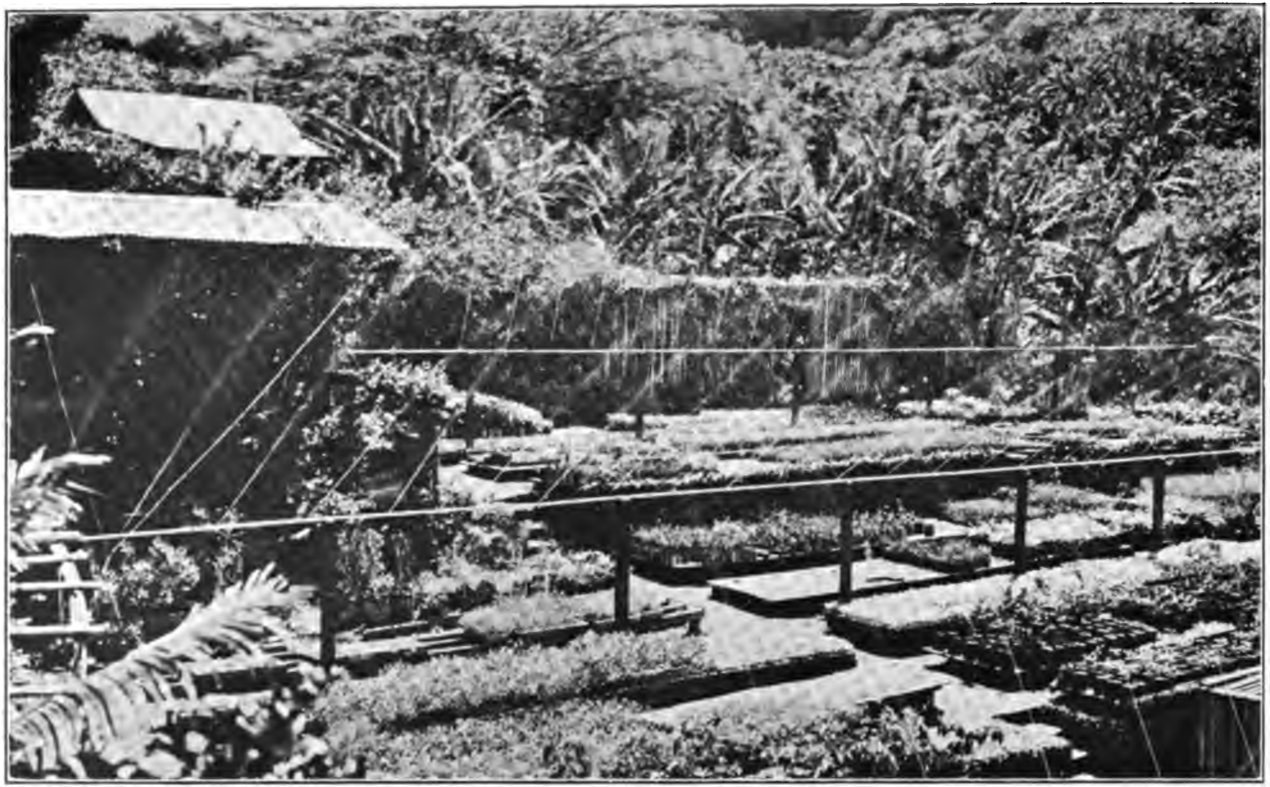

Photo by Judd.

Makiki Nursery, Honolulu, showing Skinner system of irrigation.

ese cedar, and the kauri pine. Of the last, which is the valuable timber tree from the north island of New Zealand, 640 trees have been planted out, with a 10 by 10-foot spacing, to determine their habits and rate of growth in plantation formation.

At Paumalu, on the Pupukea Reserve, 500 banyan, koa, and Australian red cedar trees were planted out in December, 1920, under an agreement whereby in return for the use of certain lands for pineapples, trees will be planted on other parts of this reserve each year. In this manner, all open spaces on this reserve will be reforested within five or six years.

On Maui, Ranger Lindsay has planted out the mountain albizzia and Australian red cedar trees on the Makawao and Kula Reserves.

It is hoped that by the use of this diversity of species in many different localities a number of valuable and fast-growing trees can be determined upon by observation for future use in reforestation projects.

ADVICE ON TREE PLANTING.

A large part of the time of the Forest Nurseryman is devoted to giving advice and assistance connected with tree planting, and this Division always stands ready to do all within its power and means to help the public in this worthy work. In addition to this, the Superintendent on May 16, 1919, prepared and submitted to the President of Oahu College, at his request, a planting scheme for the Punahou campus, with recommendations and a list of trees for planting, in which Hawaiian species of trees and shrubs were favored almost exclusively. He has also, in cooperation with the Outdoor Circle, assisted the Commanding General at Schofield Barracks by advising on the beautification of the new officers' quarters by the planting of suggested trees and shrubs. Advice on the use of hedge plants and vines for certain purposes at Fort Armstrong and Fort De Russy was also given.

TREE PLANTING THROUGHOUT THE TERRITORY.

As in past years, an attempt has been made to ascertain the number of trees planted throughout the Territory and the purposes for which the planting was done. The results for the past two years, while not complete, are shown in the following table and indicate that there has been a falling off of over half a million trees planted, when compared with the previous biennium. Disturbed labor conditions and the two dry years are no doubt responsible for this.

TREES PLANTED IN THE TERRITORY OF HAWAII IN 1919 AND 1920.

Kauai:	1919.	1920.	Total.
Gay & Robinson	1,250	3,720	4,970
Grove Farm Plantation	30,500	.....	30,500
Hawaiian Sugar Co.	20,000	.....	20,000
Kilauea Sugar Plantation Co.	10,000	34,974	44,974
Knudsen Bros.	.....	1,000	1,000
Koloa Sugar Co.	.....	2,767	2,767
Makee Sugar Co.	9,250	5,395	14,645
McBryde Sugar Co., Ltd.	4,211	4,086	8,297
Territory of Hawaii	2,174	.....	2,174
	77,385	51,942	129,327
Oahu:			
California Packing Corporation	4,000	.....	4,000
Cooke, Mrs. C. M.	.....	74	74
Ewa Plantation Co.	283	449	732
Hawaiian Pineapple Co.	101,000	3,000	104,000
Honolulu Lighthouse	.....	78	78
Koolau Agricultural Co.	.....	10,514	10,514
Laie Plantation	600	500	1,100
Marconi Wireless Tel. Co.	24	.....	24
Oahu Sugar Co.	.....	10	10
O. R. & L. Co. Ranch	2,328	620	2,948
Robinson, J. L. P. et al	.....	250	250
Territory of Hawaii	30,474	38,775	69,249
U. S. Army	5,000	8,395	13,395
U. S. Navy	.....	1,077	1,077
Wahiawa Water Co.	1,600	300	1,900
Waialua Agricultural Co.	26,030	100	26,130
	171,339	64,142	235,481
Lanai:			
Lanai Company	1,000	1,700	2,700
Maui:			
Haleakala Ranch Co.	.....	7,135	7,135
Hawaiian Commercial & Sugar Co.	1,000	1,000	2,000
Honolua Ranch	55,000	13,000	68,000
Krauss, F. G.	40	.....	40
Maui Agricultural Co.	234,600	116,350	350,950
Pioneer Mill Co.	5,000	3,275	8,275
Pogue, W. F.	250	890	1,140
Territory of Hawaii	.....	218	218
Wailuku Sugar Co.	23,213	31,041	54,254
	320,103	174,609	494,712
Hawaii:			
Hakalau Plantation Co.	124	924	1,048
Hamakua Mill Co.	.....	37,200	37,200
Hawaiian Agricultural Co.	30,000	32,320	62,320
Hawaii Consolidated Railway	212	.....	212

Plate X.

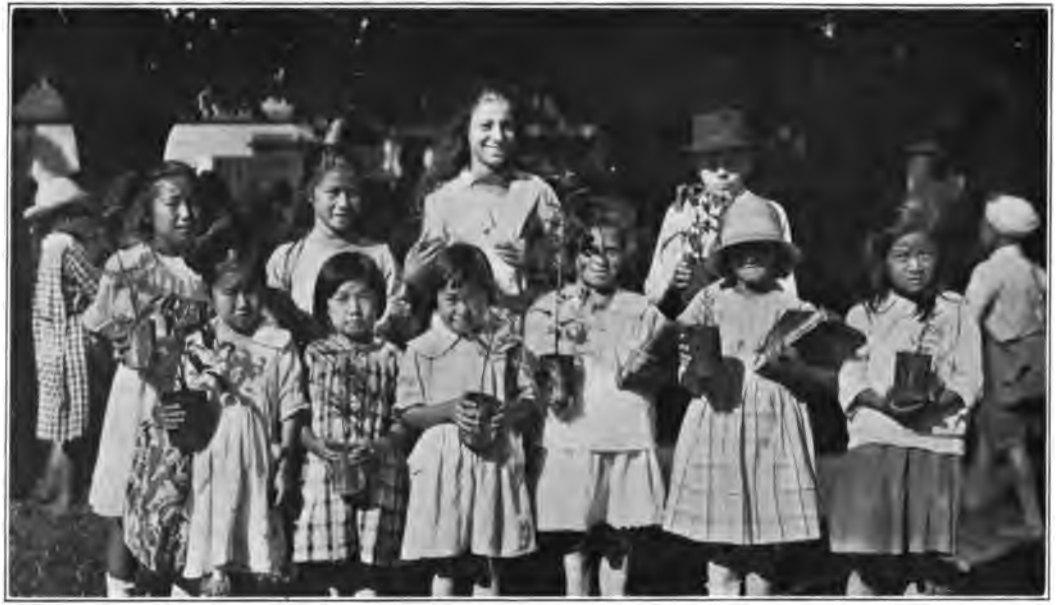

Photo by Kraebel.

Children of many races calling at Government Nursery, Honolulu, for trees to plant on Arbor Day.

Hawaiian Irrigation Co.	300	500	800
Hawi Mill and Plantation Co.	3,600	3,500	7,100
Hilo Sugar Co.	.....	15	15
H. S. P. A. Experiment Station	.....	5,500	5,500
Hutchinson Sugar Plantation Co.	1,050	.....	1,050
Kaiwiki Sugar Co.	50	1,500	1,550
Kohala Sugar Co.	24,000	15,000	39,000
Laupahoehoe Sugar Co.	.....	1,220	1,220
Niulii Mill & Plantation	.....	460	460
Onomea Sugar Co.	.....	50	50
Paauhau Sugar Plantation Co.	5,000	10,000	15,000
Parker Ranch	3,800	14,781	18,581
Union Mill Co.	.....	6,430	6,430
	68,136	129,400	197,536
Total for all Islands	636,963	420,093	1,057,056

The same figures arranged according to the principal species planted and the purpose of planting are as follows:

TREES PLANTED IN THE TERRITORY OF HAWAII IN 1919 AND 1920, SHOWING SPECIES AND PURPOSE OF PLANTING.

	Purpose of Planting				
Species.	Watershed Cover.	Fuel.	Wind-break.	Orna-ment.	Total.
1919:					
Swamp mahogany	203,424	54,044	3,350	15,000	275,818
Blue gum	38,400	106,050	.....	.....	144,450
Ironwood	16,793	80,862	25,387	10,000	133,042
Red gum	.....	22,800	12,282	1,000	36,082
Miscellaneous	8,879	600	4,931	3,573	17,983
Eucalyptus spp.	1,968	13,782	2,212	.....	17,962
Koa	8,556	.....	.....	.....	8,556
Silk oak	2,448	622	.....	.....	3,070
Totals	280,468	278,760	48,162	29,573	636,963
1920:					
Ironwood	16,549	8,563	78,141	3,449	106,702
Swamp mahogany	47,868	42,601	4,000	2,480	96,949
Blue gum	55,500	3,200	.....	.....	58,700
Red gum	31,661	1,000	14,110	800	47,571
Miscellaneous	26,121	250	998	7,398	34,767
Araucaria spp.	15,562	.....	.....	78	15,640
Eucalyptus spp.	5,095	6,821	.....	575	12,491
Australian red cedar	11,059	.....	.....	100	11,159
Ficus spp.	8,883	.....	.....	90	8,973
Red mahogany	8,707	.....	.....	.....	8,707
Java plum	.....	7,500	1,055	.....	8,555
Koa	6,114	.....	525	.....	6,639
Algaroba	3,000	240	.....	.....	3,240
Totals	236,119	70,175	98,829	14,970	420,093

From the above tables it will be observed that tree planting for the purpose of establishing a forest cover on watersheds still holds the lead, and that while the number of trees planted in 1920 was 216,870 less than in 1919, there was a far greater variety of trees in large numbers used for planting, indicating the desire to improve on the species used in past years.

MISCELLANEOUS ACTIVITIES.

COOPERATION WITH THE LAND OFFICE.

In matters pertaining to lands in and near forest reserves there has been the closest cooperation with the Land Office, especially in land exchanges and the requiring of fencing in general leases which abut forest reserves. Technical assistance and advice have also been rendered the Land Office in connection with algaroba-cutting licenses at Waianae, Oahu and Kihei, Maui, by prescribing and directing the thinnings so that the remaining trees will put on more growth and produce bigger yields of honey, beans and wood.

COOPERATION WITH THE NATIONAL PARK SERVICE.

This Division has attempted to give every possible assistance to federal officials in charge of the Hawaii National Park so as to make easier their task of placing sections of the park under administration. From April 19 to 30, 1919, at the request of Governor McCarthy, I accompanied Mr. Stephen T. Mather, Director of the National Park Service, and his party on an inspection of the Kilauea and Haleakala Sections of the park, giving information and assistance in the inspection of the lands. From March 20 to April 3, 1920, at the direction of the Acting Governor, I was with Mr. Horace M. Albright, Supervisor of the Yellowstone National Park and Field Assistant to the Director, as the special representtaive of the Territory in inspecting all three sections of the Hawaii National Park and in viewing the park possibilities of Waimea Canyon, Kauai. Our itinerary took us to Kilauea, the 1920 Kau flow, Puuhuluhulu, Puu Ulaula, where one night was spent at an elevation of 10,300 feet on the slopes of Mauna Loa, and Kona, on Hawaii; to Iao Valley and to the top of and through the crater of Haleakala, on Maui; and to Waimea Canyon and Kalalau Valley, on Kauai. Mr. Albright was more than pleased with the scenic aspect and possibilities of every place he saw, but left with the opinion that a National Park is not a present necessity at Waimea Canyon in view of the arrangements which have been made by this Division and the County of Kauai for giving the people an opportunity to visit

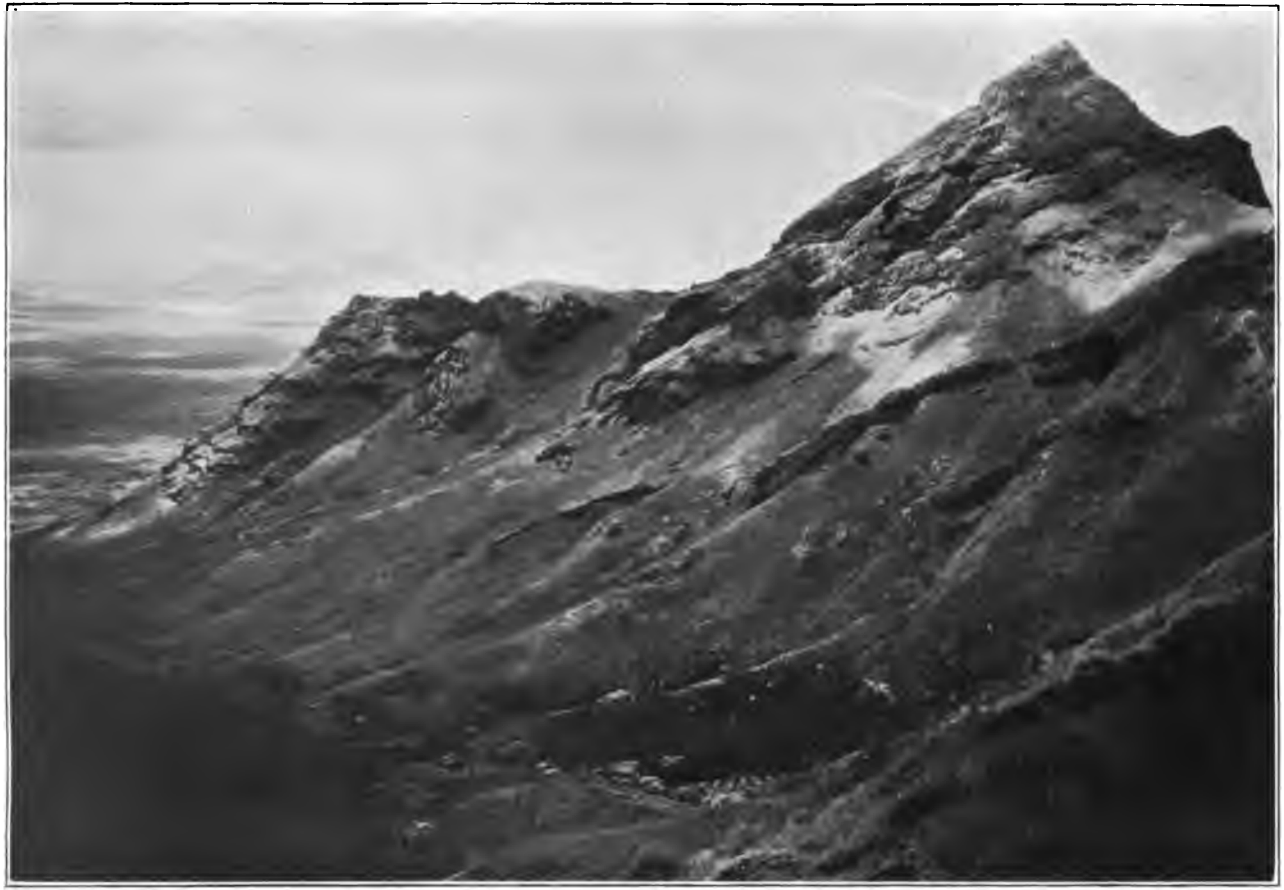

Photo by Kraebel.

Puu Kailio in the Lualualei Forest Reserve on the Waianae side of Kolekole Pass, Oahu, where the Division of Forestry is reforesting the dry slopes for the conservation of water.

the canyon and to camp in its vicinity, which abounds in such a variety of splendid recreational opportunities. Assistance was also rendered Mr. Albright by securing maps and information pertaining to the acquisition of private lands within the Kilauea Section and to government lands for the purpose of enlarging the present area of this section.

KOKEE CAMPS, KAUAI.

The area in the Na Pali-Kona Forest Reserve, on Kauai, at the bracing elevation of 3,500 feet, in the region of Kokee and Halemanu, which has been opened to campers, has been enjoyed by a large number of lovers of the out-doors during the two seasons. A total number of 37 revocable ten-year permits have been issued for the camping sites, which vary from 0.3 acre to 2 acres in size; seven permits have been revoked for non-payment of rent or upon request; and 30 permits were in effect on January 1, 1921. Substantial new improvements have been made on 10 of the camp sites. Complaints against non-compliance with the sanitary regulations were investigated in November, 1919, and the situation was satisfactorily adjusted.

FAIR EXHIBITS.

The Division participated in the Second Territorial Fair held in Honolulu on June 9 to 14, 1919, and in the Maui County Fair held at Kahului on October 21 to 23, 1920, by exhibiting its display of seedling and transplant trees, wood specimens and working erosion model to show the beneficial effect of a forest cover on the runoff. The exhibits attracted greater attention and more favorable comment than ever, and were much admired as instructive object lessons by all who saw them.

EDUCATION.

In addition to featuring the educational side of forestry at these fairs, special lectures on forestry have been given by the Superintendent as follows: At the Territorial Summer School held at Kilauea, Hawaii, two courses of lectures were given from August 1 to 18, 1919, on (1) "Elementary Forestry" and (2) "The Hawaiian Forests." On October 27 and 29 and November 1, 1919, three lectures on "Forestry in Hawaii" were given at the short course for plantation men held at the College of Hawaii under the joint auspices of the College and the Hawaiian Sugar Planters' Association. These lectures covered the beneficial effects of forests in general, a description of the native Hawaiian forests, their susceptibility to injury and the functions they perform, and methods of protecting them, and they were printed in the November, 1919, "Forester." On October 16, 1919, I began fortnightly instructions in forestry, at the request of the Commanding General of the Hawaiian Department, at the vocational school for enlisted men at Schofield Barracks, alternating with the practical instruction given by the Forest Nurseryman. This course, which lasted for two months, covered a detailed study of three leading species of trees and the practical nursery work of raising them from seed. On November 20, 1919, I gave a luncheon talk before the Rotary Club on Arbor Day.

PUBLICATIONS.

The following bulletins and articles, in addition to the monthly and annual reports which have appeared in the official magazine of the Board, "The Hawaiian Forester and Agriculturist," have been published by the Division of Forestry during the past two years:

January, 1919—"Eucalyptus Plantation. Report on Experimental Plantation," by C. S. Judd, Superintendent of Forestry.
February, 1919—"On Government Forest-Reserve Lands at Kulani, Hawaii," by J. F. Rock, Consulting Botanist.
March 17, 1919—"Report of the Division of Forestry for the Biennial Period Ended December 31, 1918."
March, 1919—"A Volume Table for Algaroba," by C. S. Judd, Superintendent of Forestry.
June, 1919—"The Arborescent Indigenous Legumes of Hawaii," Botanical Bulletin No. 5, by J. F. Rock, Consulting Botanist.
June, 1919—"The Hawaiian Genus *Kokia*—A Relative of the Cotton," Botanical Bulletin No. 6, by J. F. Rock, Consulting Botanist.
September, 1919—"The Kukui or Candlenut Tree," by C. S. Judd, Superintendent of Forestry.
November, 1919—"Forestry in Hawaii." 1. The beneficial effects of forests. 2. The native Hawaiian forests. 3. Methods of forest protection. By C. S. Judd, Superintendent of Forestry.
February, 1920—"The Koa Tree," by C. S. Judd, Superintendent of Forestry.
March, 1920—"The Poisonous Plants of Hawaii," by J. F. Rock, Consulting Botanist.
March, 1920—"The Australian Red Cedar," by C. S. Judd, Superintendent of Forestry.
April, 1920—"The Wiliwili Tree," by C. S. Judd, Superintendent of Forestry.

Plate XII.

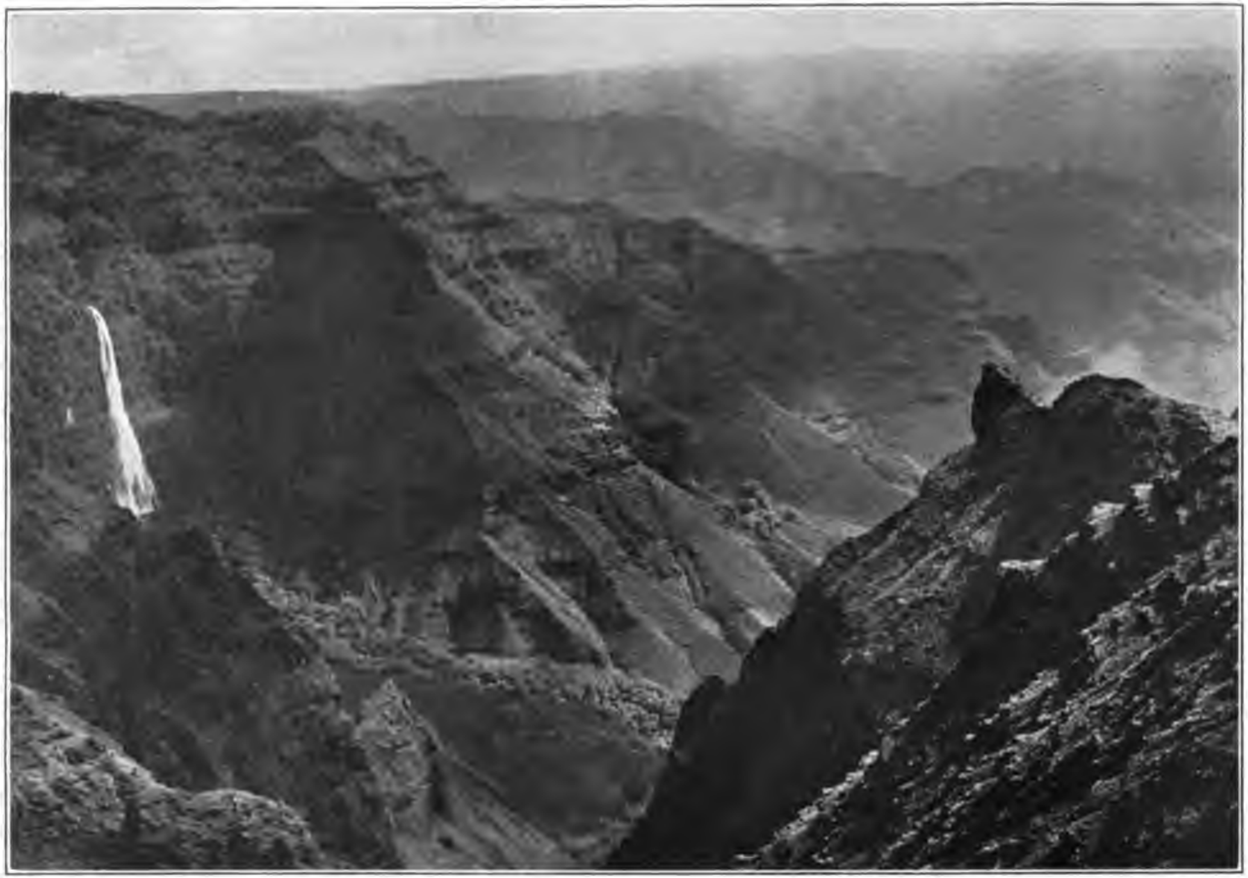

Photo by Rock.

Waipoo Falls at the head of Waimea Canyon, near the Kokee Camps in the Puu Ka Pele Forest Reserve, Kauai.

May, 1920—"The Makiki Nursery," by C. S. Judd, Superintendent of Forestry.
June, 1920—"The Kauri Pine," by C. S. Judd, Superintendent of Forestry.
November, 1920—"Exhibit at the Maui County Fair," by C. J. Kraebel, Assistant Superintendent of Forestry.
December, 1920—"Algaroba Seed Germination Tests," by C. S. Judd, Superintendent of Forestry.
In course of publication—"Revised List of Hawaiian Names of Plants," by J. F. Rock, Consulting Botanist.

SUMMARY.

In conclusion, it is a pleasure to assert that by the efforts of this Division during the past two years much progress has been made in converting the forest reserves from mere delineations on paper to protected forest areas actually under administration. The task of putting them into the best possible shape is no small undertaking, and your assistance in the work of forest protection is respectfully solicited by lending your best efforts for securing appropriations which will adequately compensate the present force, enable the appointment of three new much-needed forest rangers, and make possible the construction of fences which are now needed on forest reserve boundaries to prevent the ravages of stock, for strengthening by legislative action the present law concerning the riddance of stock from forest reserves; and for the adoption of the proposed rule to prevent the further spread of Hilo grass on the Honolulu watershed.

It is recommended that the future work of this Division be confined as closely as possible to actual work on the forest reserves.

Respectfully submitted,

C. S. JUDD,
Superintendent of Forestry and Chief Fire Warden.

LIST OF FIRE WARDENS, TERRITORY OF HAWAII

CHIEF FIRE WARDEN.

C. S. JUDD, Superintendent of Forestry, ex-officio.

DEPUTY FIRE WARDENS AT LARGE.

DAVID HAUGHS, in and for the Territory of Hawaii.
C. J. KRAEBEL, in and for the Territory of Hawaii.

DISTRICT FIRE WARDENS.

KAUAI.

A. MENEFOGLIO, in and for Wainiha Valley, District of Halelea.
W. F. SANBORN, in and for the District of Halelea, excepting Wainiha Valley.
L. D. LARSEN, in and for the District of Koolau, excepting the land of Anahola.
E. M. CHEATHAM, in and for that portion of the District of Koolau and Puna extending from the land of Anahola to the land of Olohena, inclusive.
H. D. SLOGGETT, in and for that portion of the District of Puna south of and including the land of Wailua.
F. A. ALEXANDER, in and for that portion of the District of Kona extending from Hanapepe Valley to the Puna District line.
B. D. BALDWIN, in and for that portion of the District of Kona lying between and including the Waimea, Poomau, and Kauaikinana Valleys on the west and Hanapepe Valley on the east.
E. A. KNUDSEN, in and for the District of Na Pali and that portion of the District of Kona lying to the west of Waimea, Poomau, and Kauaikinana Valleys.

OAHU.

KARSTEN THOT, in and for that portion of the District of Koolauloa from the Waialua District line to and including the land of Kaunala.
ANDREW ADAMS, in and for that portion of the District of Koolauloa lying to the north and east of the land of Kaunala.
FRANK VAUGHAN, in and for that portion of the District of Koolaupoko extending from the Koolauloa District line to the land of Heeia.
FRANK ANDRADE, in and for that portion of the District of Koolaupoko extending from and including the land of Heeia to the land of Kailua.
JOHN HERD, in and for that portion of the District of Koolaupoko extending from and including the land of Kailua to Makapuu Point.
CHARLES LUCAS, in and for that portion of the District of Kona extending from Makapuu Point to Palolo Valley.
JACK NAIWI, in and for Manoa Valley, District of Kona.
C. M. COOKE, in and for Manoa Valley, District of Kona.
L. A. MOORE, in and for Nuuanu Valley, District of Honolulu.
WM. WEINRICH, in and for that portion of the District of Ewa lying to the west of Kamehameha Highway.

JAMES GIBB, in and for that portion of the District of Ewa lying between the lands of Moanalua and Waiawa.

H. BLOOMFIELD BROWN, in and for that portion of the District of Ewa lying to the east of Kamehameha Highway between the land of Waipio and Kaukonahua Gulch.

A. A. WILSON, in and for that portion of the District of Waialua lying between Kaukonahua and Helemano Gulches.

G. M. ROBERTSON, in and for that portion of the District of Waialua lying between Helemano and Opaeula Gulches.

GEORGE WILSON, in and for that portion of the District of Waialua lying between Opaeula Gulch and the Koolauloa District line.

ERNEST BRECHT, in and for that portion of the District of Waianae lying to the west of the Waianae Mts.

MOLOKAI.

JAMES MUNRO, in and for that portion of the Island of Molokai lying to the west of Wailau Valley and the land of Mapulehu.

E. K. DUVAUCHELLE, in and for that portion of the Island of Molokai, including and lying to the east of Wailau Valley and the land of Mapulehu.

LANAI.

G. C. MUNRO, in and for the Island of Lanai.

MAUI.

A. W. COLLINS, in and for the District of Lahaina.

D. T. FLEMING, in and for the District of Kaanapali.

C. E. S. BURNS, in and for the District of Wailuku.

F. F. BALDWIN, in and for the District of Hamakuapoko and the west half of the District of Hamakualoa.

W. F. POGUE, in and for the east half of the District of Hamakualoa and that portion of the District of Koolau lying to the west of Makapipi Gulch.

MARION CABRAL, in and for that portion of the District of Koolau lying to the east of Makapipi Gulch.

JOHN CHALMERS, in and for the District of Hana.

JOHN FASSOTH, in and for the District of Kipahulu.

L. VON TEMPSKY, in and for the District of Kula and Kaupo.

HAWAII.

G. C. WATT, in and for that portion of the north half of the District of Kohala extending from the land of Kaauhuhu to the Hamakua District line.

S. P. WOODS, in and for that portion of North Kohala extending from the northern boundary of the land of Kawaihae I. to and including the land of Kaauhuhu.

A. W. CARTER, in and for the District of South Kohala.

W. P. NAQUIN, in and for the western part of the District of Hamakua extending to the west from the boundary of the land of Paauhau to the boundary of the land of Kukaiau.

D. S. MACALISTER, in and for that portion of the District of Hamakua extending from and including the land of Kukaiau to the Hilo District line.

JOHN M. ROSS.

JOE J. IGNACIO, Assistant District Fire Warden, in and for that portion of the District of Hilo extending from the Hamakua District to the land of Makahanaloa.

JOHN T. MOIR, in and for that portion of the District of Hilo extending from and including the land of Makahanaloa to the land of Kikala.

JAMES HENDERSON, in and for that portion of the District of Hilo extending from the Puna District line to and including the land of Kikala.

A. J. WATT, in and for the District of Puna.

JAMES CAMPSIE, in and for that portion of the District of Kau extending from the Puna District line to and including the land of Punaluu.

GEORGE GIBB, in and for that portion of the District of Kau extending from the land of Punaluu to the Kona District line.

R. A. McWAYNE, in and for that portion of the District of Kona extending from the Kau District line to and including the land of Kaapuna.

T. C. WHITE, in and for that portion of the District of Kona extending from the land of Kaapuna to and including the land of Hookena.

A. C. DOWSETT, in and for that portion of the District of Kona extending from the land of Hookena to and including the land of Kaawaloa.

T. C. WHITE, in and for that portion of the District of Kona extending from the land of Kaawaloa to and including the land of Kahaluu.

A. J. STILLMAN, in and for that portion of the District of Kona extending from the land of Kahaluu to the Kohala District line.

FOREST RANGERS.

Kauai.

HOSEA K. LOVELL, for Kauai.

Oahu.

DAVID KAPIHI, for Tantalus and Makiki.
E. H. HIPPLE, for Palolo, Manoa and Nuuanu.
DANIEL KAPAHU, for Waianae District except Waianae Valley.

Maui.

JAMES LINDSAY, for Maui.

Hawaii.

A. J. W. MACKENZIE, for Olaa.
CHARLES E. STONE, for South Kona and Kau.

ANTONE P. AGUIAR, for the Panaewa Reserve.
HARRY L. DENISON, for the Kohala Mt. and Hamakua Pali Reserves.

FOREST RANGER AT LARGE.

V. L. ELLIS, for the Territory of Hawaii.

HONORARY FOREST RANGERS.

J. P. PICO, for the Waianae-kai Reserve, Oahu.
B. CARTWRIGHT, JR., for the enforcement of Rule IV. on Oahu.

NURSERY AGENTS.

JOE RITA, JR., Kalaheo, Kauai.
A. ROCHA, Waiahole, Oahu.
JAMES LINDSAY, Haiku, Maui.
BRO. M. NEWELL, Hilo, Hawaii.

DISTRICT FORESTERS.

Kauai.

L. D. Larsen, E. Broadbent, J. M. Lydgate, W. D. McBryde, E. A. Knudsen, B. D. Baldwin.

Oahu.

Andrew Adams, L. L. McCandless, John Herd, W. W. Goodale.

Molokai.

James Munro and E. K. Duvauchelle.

Lanai.

G. C. Munro.

Maui.

A. W. Collins, F. F. Baldwin, W. F. Pogue, L. von Tempsky, J. H. Raymond, D. T. Fleming, John Fassoth.

Hawaii.

G. C. Watt, A. W. Carter, W. P. Naquin, J. M. Ross, George Gibb, and James Campsie.

LANDS IN FOREST RESERVES.

TERRITORY OF HAWAII.

January 1, 1921.

Island of Kauai.

Name of Reserve	Name of Land	Private Land, Acres	Government Land			Total Acres
			Leased Acres	Unleased Acres	Total Acres	
NA PALI KONA No. 13 Proclaimed June 12, 1907	Haena	500	....	....	....	500
	Hanakapiai	....	....	130	130	130
	Na Pali ...	....	....	10,340	10,340	10,340
	Milolii	....	5,808*	....	5,808	5,808
	Waimea ...	....	....	24,372	24,372	24,372
	Makaweli ..	10,030	....	....	....	10,030
	Hanapepe ..	9,360	....	....	....	9,360
		19,890	5,808	34,842	40,650	60,540
PUU KA PELE No. 45 Proclaimed Dec. 31, 1918	Waimea ...	....	....	1,800	1,800	1,800
	Waimea ...	....	2,685*	....	2,685	2,685
		....	2,685	1,800	4,485	4,485
PAPAPA-HOLAHOLA SPRING No. 41 Proclaimed June 19, 1918	Kalaheo ...	....	....	54	54	54
LIHUE-KOLOA No. 19 Proclaimed June 5, 1909	Hanapepe ..	10	....	....	....	10
	Wahiawa ..	2,060	....	15	15	2,075
	Kalaheo ...	....	....	1,275	1,275	1,275
	Lawai	350	....	....	....	350
	Koloa	980	....	....	....	980
	Haiku	2,900	....	....	....	2,900
	Hanamaulu	9,361	....	....	....	9,361
	Wailua	....	....	11,231	11,231	11,231
	N. Olohena .	....	....	150	150	150
	Waipouli ..	....	....	270	270	270
		15,661	....	12,941	12,941	28,602
NONOU No. 44 Proclaimed Dec. 31, 1918	Wailua Uka	....	....	214	214	214
	Wailua Kai	....	361†	....	361	361
	Waipouli and N. Olohena .	....	42‡	....	42	42
	S. Olohena .	....	201‡	....	201	201
		....	604	214	818	818

Island of Kauai—Continued.

Name of Reserve	Name of Land	Private Land, Acres	Government Land Leased Acres	Government Land Unleased Acres	Government Land Total Acres	Total Acres
KEALIA No. 6 Proclaimed Mar. 9, 1906	Kapaa	....	....	2,290	2,290	2,290
	Kealia	2,470	....	....	....	2,470
	Kamalomaloo	....	....	630	630	630
	Anahola ...	....	....	3,660	3,660	3,660
		2,470	....	6,580	6,580	9,050
MOLOAA No. 20 Proclaimed June 5, 1909	Aliomanu ..	125	....	....	....	125
	Moloaa	8	....	....	....	8
	Papaa-Moloaa	....	....	2,160	2,160	2,160
	Pilaa	40	....	....	....	40
	Papaa	5	....	....	....	5
	Papaa	....	....	1,418	1,418	1,418
	Kahili	475	....	....	....	475
	Kilauea ...	1,390	....	....	....	1,390
		2,043	....	3,578	3,578	5,621
HALELEA No. 5 Proclaimed Aug. 24, 1914	Kalihiwai ..	5,685	....	....	....	5,685
	Hanalei ...	....	....	8,340	8,340	8,340
	Waioli	....	....	2,650	2,650	2,650
	Waipa	800	....	....	....	800
	Lumahai ...	8,975	....	....	....	8,975
	Wainihi ...	11,050	....	....	....	11,050
		26,510	....	10,990	10,990	37,500
Totals for Kauai		66.574	9,097	70.999	80.096	146.670

*Lease expires June 1, 1921.
†Lease expires July 1, 1921.
‡Lease expires January 14, 1921.

Island of Oahu.

Name of Reserve	Name of Land	Private Land, Acres	Government Land, Acres*	Total Acres
KUAOKALA No. 30 Proclaimed June 4, 1913	Kuaokala	....	434	434
MAKUA-KEAAU No. 29 Proclaimed June 4, 1913	Kahanahaiki	....	970	970
	Makua	....	1,660	1,660
	Ohikilolo	340	....	340
	Keaau	....	1,850	1,850
		340	4,480	4,820
WAIANAE-KAI No. 10 Proclaimed Sept. 7, 1906	Waianae-Kai	....	3,546	3,546
	Waianae Grants .	107	....	107
		107	3,546	3,653
LUALUALEI No. 11 Proclaimed Nov. 30, 1906	Lualualei	....	3,743	3,743
NANAKULI No. 28 Proclaimed June 4, 1913	Nanakuli	....	1,010	1,010
KULIOUOU No. 35 Proclaimed Feb. 13, 1914	Kuliouou	....	214	214
MANOA RANGER STATION No. 38 Proclaimed May 9, 1916	Kahoiwai	....	15	15
ROUND TOP No. 39 Proclaimed Aug. 10, 1916	Makiki	....	115	115
HONOLULU WATERSHED No. 34 Proclaimed Oct. 13, 1913	Palolo	....	910	910
	Manoa	....	780	780
	Makiki	....	563	563
	Kalawahine	....	255	255
	Nuuanu	....	2,160	2,160
	Kalihi	....	330	330
	Scattered in above	1,952	....	1,952
		1,952	4,998	6,950

Island of Oahu—Continued.

Name of Reserve	Name of Land	Private Acres Land,	Government Land, Acres*	Total Acres
EWA No. 7 Proclaimed Mar. 9, 1906	Halawa	3,846	....	3,846
	Aiea	....	383	383
	Kalauao	1,538	....	1,538
	Waimalu	2,238	....	2,238
	Waiau	1,320	....	1,320
	Waimano	....	790	790
	Manana	1,090	....	1,090
	Waiawa	4,040	....	4,040
	Waipio	5,080	....	5,080
	Waianae-Uka	4,247	....	4,247
	Wahiawa	....	3,978	3,978
		23,399	5,151	28,550
WAIAHOLE No. 42 Proclaimed June 19, 1918	Makawai	....	889	889
	Kapikokau	....	54	54
	Waianu I	....	186	186
	Makawai Apanas	5	....	5
	Waianu I Apana .	1	....	1
	Waianu I, Portion	2	....	2
	Hanakea	32	....	32
		40	1,129	1,169
HAUULA No. 47 Proclaimed Dec. 31, 1918	Kahana	3,920	....	3,920
	Punaluu L. C. A.'s	28	....	28
	Punaluu	2,950	....	2,950
	Makaua	48	....	48
	Waiono	47	....	47
	Kaluanui	1,033	....	1,033
	Makao	24	....	24
	Hauula	....	1,143	1,143
		8,050	1,143	9,193
KAIPAPAU No. 1 Proclaimed Nov. 10, 1904	Kaipapau	....	913	913
PUPUKEA No. 21 Proclaimed May 10, 1910	Pupukea-Paumalu	....	864	864
MOKULEIA No. 46 Proclaimed Dec. 31, 1919	Mokuleia	....	5,850	5,850
	Kawaihapai	....	320	320
	Kealia	....	120	120
		....	6,290	6,290
Totals for Oahu		33,888	34,045	67,933

*There are no leased government lands in any reserve on Oahu.

Island of Molokai.

Name of Reserve	Name of Land	Private Land, Acres	Government Land			Total Acres
			Leased Land, Acres	Unleased Land, Acres	Total Acres	
MOLOKAI No. 26 Proclaimed Sept. 11, 1912	Iloli	156	....	....	....	156
	Naiwa	70	....	....	....	70
	Kahanui ...	317	....	....	....	317
	Kalamaula .	....	....	1,621	1,621	1,621
	Kahanui G-3437 ...	1,048	....	....	....	1,048
	Kaunakakai	965	....	....	....	965
	Kapaakea ..	....	....	220	220	220
	Kamiloloa 1	....	....	490	490	490
	Kamiloloa 2	....	....	550	550	550
	Makakupaia mauka ...	....	....	490	490	490
	Makakupaia makai ...	654	....	....	....	654
	Kawela	3,850	....	....	....	3,850
	Makolelau .	253	....	....	....	253
	Kamalo	1,600	....	....	....	1,600
	Kapualei Kamueli Wawaia } .	923	....	....	....	923
	Puaahala ..	....	....	163	163	163
	Kaamola ...	33	....	....	....	33
	Keawanui ..	182	....	....	....	182
	W. Ohia ...	172	....	....	....	172
	E. Ohia ...	....	220*	....	220	220
	Manawai ..	416	....	....	....	416
	Kahananui .	....	182†	....	182	182
	Ualapue ...	....	194†	....	194	194
	Kaluaaha ..	694	....	....	....	694
	Mapulehu ..	1,007	....	....	....	1,007
	Ili o Punaula	152	....	....	....	152
	Pukoo	....	....	124	124	124
	Kupehe	63	....	....	....	63
	Ahaino 1 ..	....	....	96	96	96
	Ahaino 2 ..	100	....	....	....	100
	Honomuni ..	415	....	....	....	415
	Kawaikapu	67	....	....	....	67
	Kainalu ...	572	....	....	....	572
	Puelehe ...	14	....	....	....	14
	Puniuohua 1	2	....	....	....	2
	Puniuohua 2	2	....	....	....	2
	Waialua ...	627	....	....	....	627
	Moanui	282	....	....	....	282
	Honouliwai .	....	....	378	378	378
	Honoulimaloo	175	....	....	....	175
	Lupehu	83	....	....	....	83
	Pohakupili .	9	....	....	....	9
	Mokea	218	....	....	....	218
	Keopukau-uku	16	....	....	....	16
	Keopukaloa	810	....	....	....	810
	Halawa	7,190	....	....	....	7,190
	Wailau	....	8,540‡	....	8,540	8,540
	Pelekunu ..	4,512	....	....	....	4,512
	Waikolu ...	3,400	....	....	....	3,400
	Makanalua .	142	....	....	....	142
	Kahanui G-3539 ..	215	....	....	....	215
		31,406	9,136	4,132	13,268	44,674
Totals for Molokai		31,406	9,136	4,132	13,268	44,674

Island of Maui.

Name of Reserve	Name of Land	Private Land, Acres	Government Land			Total Acres
			Leased Acres	Unleased Acres	Total Acres	
WEST MAUI No. 14 Proclaimed April 21, 1908	Ukumehame and Olowalu	....	....	7,655	7,655	7,655
	Launiupoko	1,455	....	....	....	1,455
	Puehuehu	440	....	....	....	440
	Kauaula	1,455	....	....	....	1,455
	Kuia, Panaewa and Paunau	....	....	2,100	2,100	2,100
	Paunau	210	....	....	....	210
	Kuholilea	120	....	....	....	120
	Puuiki	....	....	205	205	205
	Halakaa	255	....	....	....	255
	Wahikuli	....	....	1,550	1,550	1,550
	Hanakaoo	720	....	....	....	720
	Honokowai	....	....	1,410	1,410	1,410
	Kahana and Mahinahina	330	....	....	....	330
	Mailepai	120	....	....	....	120
	Alaeloa	30	....	....	....	30
	Honokahua Honolua and Honokohau	5,720	....	....	....	5,720
	Kahakuloa	....	....	5,900	5,900	5,900
	Waihee	4,220	....	....	....	4,220
	Kou	....	....	285	285	285
	Hananui	200	....	....	....	200
	Waiehu	1,190	....	....	....	1,190
	Wailuku	4,935	....	....	....	4,935
	Waikapu	3,935	....	....	....	3,935
	Polipoli	....	....	42	42	42
		25,335	....	19,147	19,147	44,482
KULA No. 27 Proclaimed Sept. 11, 1912	Papaanui	....	....	370	370	370
	Kamaole	....	....	612	612	612
	Waiohuli-Keokea	....	....	2,450	2,450	2,450
	Kaonoulu	804	....	....	....	804
	Alae 1 and 2	202	....	....	....	202
	Alae 3 and 4	....	....	70	70	70
	Waiakoa	....	....	1,567	1,567	1,567
		1,006	....	5,069	5,069	6,075
WAIHOU SPRING No. 18 Proclaimed June 5, 1909	Makawao	....	....	74	74	74
	Makawao	10	....	....	....	10
		10	....	74	74	84
MAKAWAO No. 15 Proclaimed Apr. 21, 1908	Makawao	....	....	2,093	2,093	2,093

Island of Maui—Continued.

Name of Reserve	Name of Land	Private Land, Acres	Government Land			Total Acres
			Leased Acres	Unleased Acres	Total Acres	
KOOLAU No. 4 Proclaimed Aug. 24, 1905	*Opana *Peahi *Haiku	10,899	....	....	....	10,899
	*Halehaku .	1,840	....	....	....	1,840
	Honopu-W. .					
	Makaiwa ...	....	....	4,800	4,800	4,800
	E. Makaiwa-Keopuka .	....	....	1,400	1,400	1,400
	Honomanu .	....	....	2,000	2,000	2,000
	Keanae, mauka ...	....	8,750†	....	8,750	8,750
	Wailua 1-2 .	....	1,280†	....	1,280	1,280
	Wailua-Ulaino ...	....	3,000†	....	3,000	3,000
	Wailua-Ulaino ...	....	....	9,000	9,000	9,000
		12,739	13,030	17,200	30,230	42,969
HANA No. 12 Proclaimed Nov. 30, 1906	Hana Forest	....	....	11,572	11,572	11,572
	W. Honomaele	187	....	....	....	187
	E. Honomaele	....	....	130	130	130
	Kawela-Kaeleku .	....	....	65	65	65
	Wakiu	....	....	18	18	18
	Aleamai ...	357	....	....	....	357
	Haneoo	84	....	....	....	84
	Kakio	....	....	700	700	700
	Waiohonu ..	....	....	33	33	33
	Puukai-Papahawahawa	....	....	68	68	68
	Muolea	430	....	....	....	430
	Koali-Puuhaoa	....	....	600	600	600
	Wailua	....	....	270	270	270
	Puaaluu	....	....	311	311	311
		1,058	....	13,767	13,767	14,825
KIPAHULU No. 36 Proclaimed Aug. 20, 1914	Kaumakani-Papauluana .	....	....	550	550	550
	Alaeiki	....	....	180	180	180
	Alaenui	5,705	....	....	....	5,705
	Kakahale-Kokoo ...	....	....	98	98	98
	Kukuiula ..	....	....	797	797	797
	Kukuiula (Grs.) ...	295	....	....	....	295
	Kaniaula ...	....	....	2,975	2,975	2,975
		6,000	....	4,600	4,600	10,600
Totals for Maui		46,148	13,030	61,950	74,980	121,128

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*Surrendered to the custody of the Board of Agriculture and Forestry November 12, 1906, under the provisions of Sec. 490, R. L. H., 1915, for the period to February 26, 1923.

†Lease expires February 26, 1923.

Island of Hawaii.

Name of Reserve	Name of Land	Private Land, Acres	Government Land			Total Acres
			Leased Acres	Unleased Acres	Total Acres	
KOHALA MT. No. 31 Proclaimed Oct. 13, 1913	Awini	500	....	....	....	500
	Awini	....	....	100	100	100
	Honokane ..	5,410	....	....	....	5,410
	Pololu	....	....	1,000	1,000	1,000
	Makanikahio 1	64	....	....	....	64
	Makanikahio 2	71	....	....	....	71
	Waiapuka ..	197	....	....	....	197
	Niulii	560	....	....	....	560
	Makapala ..	530	....	....	....	530
	Aamakao ..	710	....	....	....	710
	Halawa	493	....	....	....	493
	Halelua	15	....	....	....	15
	Nunulu	38	....	....	....	38
	Lamaloloa-Kaiholena	140	....	....	....	140
	Lamaloloa .	....	....	24	24	24
	Kawaihae I.	....	....	3,370	3,370	3,370
	Kawaihae II.	120	....	....	....	120
	Puukawaiwai-Panoluukia-Kapia	....	....	360	360	360
	Pauahi	....	....	150	150	150
	Momoualoa .	....	....	130	130	130
	Ouli	190	....	....	....	190
	Lanikepu ..	25	....	....	....	25
	Lanikepu ..	....	....	435	435	435
	Waikoloa ..	250	....	....	....	250
	Puukapu ...	....	....	8,385	8,385	8,385
	Waipio	3,560	....	....	....	3,560
	Lalakea	1,540	....	....	....	1,540
	Kukuihaele .	10	....	....	....	10
	Waikoekoe .	1,000	....	....	....	1,000
	Kamoku ...	....	20[1]	....	20	20
	Keaa	....	230[1]	....	230	230
		15,423	250	13,954	14,204	29,627
HAMAKUA-PALI No. 2 Proclaimed Dec. 23, 1904	Muliwai ...	....	....	3,575	3,575	3,575
	Waimanu and Laupahoehoe 1 .	....	....	4,943	4,943	4,943
	Waimanu kuleanas .	61	....	....	....	61
	Waimanu homesteads	196	....	....	....	196
	Waimanu ..	....	200[2]	....	200	200
	Laupahoehoe 2	2,350	....	....	....	2,350
	Nakooka ...	....	....	1,640	1,640	1,640
	Apua	....	....	1,260	1,260	1,260
	Waikapu ...	....	....	1,980	1,980	1,980
	Honopue ...	....	....	2,220	2,220	2,220
	Awini	....	....	515	515	515
		2,607	200	16,133	16,333	18,940

Island of Hawaii—Continued.

Name of Reserve	Name of Land	Private Land, Acres	Government Land			Total Acres
			Leased Acres	Unleased Acres	Total Acres	
HAUOLA No. 22 Proclaimed June 13, 1910	Hauola	....	....	7	7	7
MAUNA KEA No. 17 June 5, 1909	Kaohe	....	....	66,600	66,600	66,600
HILO No. 3 Proclaimed July 24, 1905	Humuula ...	....	....	3,901	3,901	3,901
	Kahoahuna .	....	....	46	46	46
	Waipunalei .	1,470	....	....	....	1,470
	Laupahoehoe Weloka ..	....	....	11,845	11,845	11,845
	Maulua	7,989	....	....	....	7,989
	Waikumalo-Maulua ..	....	....	790	790	790
	Piha	....	....	3,780	3,780	3,780
	Nanue	145	....	....	....	145
	Honohina ..	5,555	....	....	....	5,555
	Opea-Peleau	....	....	230	230	230
	Umauma ...	1,561	....	....	....	1,561
	Kamaee-Wailua ...	....	....	930	930	930
	Hakalau ...	9,826	....	....	....	9,826
	Wailea-Kaiwiki .	....	....	3,834	3,834	3,834
	Honomu-Kuhua ...	....	....	926	926	926
	Makahanaloa	3,949	....	....	....	3,949
	Onomea	773	....	....	....	773
	Kahalii	183	....	....	....	183
	Papaikou ...	10,269	....	....	....	10,269
	Pahoehoe ..	176	....	....	....	176
	Paukaa	6,221	....	....	....	6,221
	Kikala	90	....	....	....	90
	Kalalau ...	918	....	....	....	918
	Puueo	436	....	....	....	436
	Piihonua ...	....	33,941[3]	....	33,941	33,941
	Punahoa ...	216	....	....	....	216
		49,777	33,941	26,282	60,223	110,000
UPPER WAIAKEA No. 32 Proclaimed Oct. 13, 1913	Piihonua ..	....	3,800[3]	....	3,800	3,800
	Waiakea ...	....	....	51,200	51,200	51,200
			3,800	51,200	55,000	55,000
PANAEWA No. 40 Proclaimed Apr. 11, 1917	Waiakea ...	....	....	1,750	1,750	1,750
OLAA No. 48 Proclaimed Dec. 31, 1918	Olaa	....	....	11,061	11,061	11,061
	Olaa	....	8,589[4]	....	8,589	8,589
	Olaa	....	99[5]	....	99	99
	Olaa	....	100[5]	....	100	100
	Olaa	....	98[6]	....	98	98
		....	8,886	11,061	19,947	19,947

Island of Hawaii—Continued.

Name of Reserve	Name of Land	Private Land, Acres	Government Land			Total Acres
			Leased Acres	Unleased Acres	Total Acres	
UPPER OLAA No. 33 Proclaimed Oct. 13, 1913	Olaa	....	....	9,280	9,280	9,280
OLAA FOREST PARK No. 37 Proclaimed Aug. 20, 1914	Olaa	....	....	532	532	532
PUNA No. 25 Proclaimed June 29, 1911	Makuu-Kaohe ...	....	....	18,350	18,350	18,350
	Kaimu-Kehena Kapaahu-Kamaili	....	....	1,500	1,500	1,500
		....	....	19,850	19,850	19,850
KEAUOHANA No. 43 Proclaimed June 19, 1918	Keauohana .	....	....	272	272	272
KAU No. 9 Proclaimed Aug. 2, 1906	Puumakaa-Kiolakaa .	....	5,750[7]	....	5,750	5,750
	Waiohinu ..	....	....	10,740	10,740	10,740
	Kahilipalinui	165	....	....	....	165
	Kawala-Kaunamano.	....	....	380	380	380
	Kioloku	....	....	216	216	216
	Hionaa-Hokukano-mauka	....	....	345	345	345
	Kaalaiki ...	....	....	10,705	10,705	10,705
	Hilea-nui ..	2,620	....	....	....	2,620
	Hilea-iki ...	37	....	....	....	37
	Ninole-Wailau ..	....	....	6,140	6,140	6,140
	Punaluu	1,275	....	....	....	1,275
	Mohokea 1-2	....	....	1,876	1,876	1,876
	Moaula-Kopu-Makaka ..	....	....	7,382	7,382	7,382
	Moaula-Kopu-Makaka ..	....	46[8]	....	46	46
	Paauau	1,675	....	....	....	1,675
	Kaauhuhuula	....	....	3,009	3,009	3,009
	Kuaiwa	483	....	....	....	483
	Kaalaala-Makakupu	....	....	7,204	7,204	7,204
	Kapapala ..	....	....	7,046	7,046	7,046
		6,255	5,796	55,043	60,839	67,094

Island of Hawaii—Continued.

Name of Reserve	Name of Land	Private Land, Acres	Government Land			Total Acres
			Leased Acres	Unleased Acres	Total Acres	
SOUTH KONA No. 24 Proclaimed May 17, 1911	Kaohe	....	....	1,555	1,555	1,555
	Kaohe 4	760	....	....	....	760
	Kukuiopae .	....	....	2,760	2,760	2,760
	Olelomoana 1	810	....	....	....	810
	Olelomoana-Opihihali .	....	2,400[9]	1,485	3,885	3,885
	Kipahoehoe.	....	....	4,590	4,590	4,590
	Honomalino.	....	....	2,540	2,540	2,540
	Kapua	6,122	....	....	....	6,122
	Kaulana-mauna ...	....	....	2,060	2,060	2,060
	Manuka ...	....	....	11,870	11,870	11,870
		7,692	2,400	26,860	29,260	36,952
HONUAULA No. 8 Proclaimed Apr. 4, 1906	Honuaula ..	....	....	665	665	665
WAIAHA SPRING No. 16 Proclaimed Apr. 21, 1908	Waiaha 2 ..	....	....	193	193	193
Totals for Hawaii		81,754	55,273	299,682	354,955	436,709

[1] Lease expires September 8, 1928.
[2] Lease expires November 22, 1922.
[3] Lease expires March 21, 1921.
[4] Lease expires February 5, 1932.
[5] Lease expires May 9, 1932.
[6] Lease expires November 22, 1932.
[7] Lease expires May 24, 1923.
[8] Lease expires June 16, 1921.
[9] Lease expires June 9, 1926.

SUMMARY.

Island	No. of Reserves	Private Land, Acres	Leased Government Land, Acres	Unleased Government Land, Acres	Total Government Land, Acres	Total All Lands, Acres
Kauai	8	66,574	9,097	70,999	80,096	146,670
Oahu	15	33,888	....	34,045	34,045	67,933
Molokai ...	1	31,406	9,136	4,132	13,268	44,674
Maui	7	46,148	13,030	61,950	74,980	121,128
Hawaii	16	81,754	55,273	299,682	354,955	436,709
Totals ...	47	259,770	86,536	470,898	557,344	817,114

REPORT OF THE FOREST NURSERYMAN

Honolulu, Hawaii, December 31, 1920.

Superintendent of Forestry,
Honolulu, Hawaii.

Dear Sir: I respectfully submit the following report for the calendar years 1919 and 1920:

COLLECTION AND EXCHANGE OF SEED.

The collecting of seed has been continued with the aid of two boys. A number of trees raised from seed received through our exchange system and from individuals are now bearing. A plentiful supply of seed of the following species can be collected: *Juniperus bermudiana,* introduced by Mr. Gerrit P. Wilder, *Juniperus australis,* received through our exchange system from Jamaica, and the African tulip tree, *Spathodea campanulata,* the seed of which was received by Mr. C. S. Judd from Madagascar in 1916. From two pods we were able to propagate 2,000 seedlings which were distributed to people all over the islands. The first trees of this species which we have noticed bearing seed were found during August, 1920, at different localities in the Makiki District, University of Hawaii grounds and at other places in and around the city. The Australian red cedar, *Cedrela australis,* introduced by Mr. E. C. Smith in 1914, seeded during 1919 for the first time. Other trees of recent introduction may also be found bearing seed.

TREES DISTRIBUTED FROM GOVERNMENT NURSERIES DURING 1919 AND 1920.

Oahu: 1919.

Makiki and King St. Nurseries:

	Seedlings	Transplants	Pot Grown	Total
Sold	1,000	450	1,732	3,182
Gratis				
Arbor Day	....	....	6,392	6,392
Forest Reserves	17,900	3,260	6,031	27,191
Homesteaders	3,000	1,300	4	4,304
Military Posts	19,200	5,913	2,093	27,206
Parks	....	....	52	52
Schools	....	....	80	80
Street Planting	....	....	949	949
Miscellaneous	24,000	9,000	3,084	36,084
	65,100	19,923	20,417	105,440

	Seedlings	Transplants	Pot Grown	Total
Kauai:				
Kalaheo Nursery, Including Arbor Day	....	....	3,602	3,602
Maui:				
Haiku Nursery, including Arbor Day	40,500	....	....	40,500
Hawaii:				
Hilo Nursery, including Arbor Day	....	6,303	6,000	12,303
	105,600	26,226	30,019	161,845
Plantation Companies, Etc.	103,000	16,300	10,936	130,236
Totals	208,600	42,526	40,955	292,081
	1920.			
Oahu:				
Makiki and King St. Nurseries:				
Sold	....	700	1,336	2,036
Gratis				
Arbor Day	....	....	4,370	4,370
Forest Reserves	31,200	9,816	5,209	46,225
Homesteaders	....	100	340	440
Military Posts	4,000	3,200	2,803	10,003
Schools	141	....	....	141
Street Planting	....	412	....	412
Miscellaneous	....	2,005	2,550	4,555
	35,341	16,233	16,608	68,182
Kauai:				
Kalaheo Nursery, including Arbor Day	....	....	7,896	7,896
Maui:				
Haiku Nursery, including Arbor Day	11,100	10,330	1,163	22,593
Hawaii:				
Hilo Nursery, including Arbor Day	500	1,113	6,234	7,847
	46,941	27,676	31,901	106,518
Plantation Companies, Etc.	114,600	2,550	298	117,448
Totals	161,541	30,226	32,199	223,966

Total Tree Distribution 1919 and 1920 516,047

Government Realizations.

Turned into the Treasury.

1919.

Sale of Plants	$ 67.60
Rent of Office, Nursery Grounds	455.00
Rebate on Drugs Returned	123.33
Price of Magazine Returned	3.00
Two Days' Labor not Performed (Haiku)	3.23
Total	$ 652.16

1920.

Sale of Plants, Government Nursery	$ 35.80
Sale of Plants, Kalaheo Nursery, Kauai	98.25
Rent of Office, Nursery Grounds	420.00
Total	$ 554.05

Special Funds.

Preservation and Extension of Forestry and Forest Reserves.

1919.

Rents and Fees	$ 156.00
Sale of Black Sand, Makiki, Oahu	178.50
Sale of Cord Wood, Olaa, Hawaii	154.25
Sale of Charcoal, Tantalus, Oahu	114.75
Kokee Camps, Kauai—Fees	305.61
Total	$ 909.11

1920.

Rents and Fees	$ 212.50
Sale of Black Sand, Makiki, Oahu	297.50
Sale of Charcoal, Tantalus, Oahu	8.92
Kokee Camps, Kauai—Fees	489.08
Total	$1,008.00

Animal Industry Revolving Fund.

To Sale of Vaccines, 1919	$ 448.25
To Sale of Vaccines, 1920	1,645.35

PLANTATION COMPANIES AND OTHER CORPORATIONS, ETC.

The number of trees distributed to plantation companies and other corporations during 1919 and 1920 amounted to 247,684, as follows:

	1919.				1920.			
	Seedlings	Transplants	Pot Grown	Total	Seedlings	Transplants	Pot-Grown	Total
Eucalyptus resinifera	5,500	.....	.....	5,500	25,000	.....	.....	25,000
,, crebra	4,500	.....	.....	4,500	.....	.....	.....	.....
,, pilularis	15,000	.....	.....	15,000	11,800	.....	.....	11,800
,, citriodora	10,000	.....	.....	10,000	7,000	.....	.....	7,000
,, globulus	12,000	.....	.....	12,000	20,000	.....	.....	20,000
,, robusta	45,000	.....	.....	45,000	29,000	.....	.....	29,000
,, rostrata	16,000	.....	.....	16,000	5,400	.....	.....	5,400
,, rudis	10,000	.....	.....	10,000	2,000	.....	.....	2,000
Catalpa sps.	.....	.....	.....	.....	4,400	.....	.....	4,400
Cedrela australis	.....	.....	36	36	10,000	.....	.....	10,000
Casuarina equisetifolia	.....	.....	.....	.....	.....	2,550	298	2,848
Ficus religiosa	1,000	.....	.....	1,000	.....	.....	.....	.....
Cryptomeria japonica	10,000	.....	1,200	11,200	.....	.....	.....	.....
Totals	129,000	.....	1,236	130,236	114,600	2,550	298	117,448

Total for two years—247,684

MAKIKI STATION.

The regular work at the Makiki station consisted of mixing and sterilizing soil, transplanting seedlings, propagating by cuttings, sawing up wood for seed and transplant boxes, etc.

The proposed arboretum which is to be located in and will eventually occupy the whole of upper Makiki and Hering Valleys is certainly a step in the right direction. A good collection of trees, shrubs and vines are to be found already in and around the station and will form the nucleus of the arboretum. When the whole of both valleys are occupied with different kinds of trees properly tagged with their common and scientific names, the collection will not only be of interest and benefit to arboriculturists but also to many visitors who are always anxious to learn the names and history of the trees to be found growing in these islands.

HONOLULU WATERSHED.

The work on the watershed consisted of clearing and extending trails, rooting out pests, planting trees and assisting at Makiki station during bad weather. As most of the land being planted consists of rocky and precipitous patches, the work of reforestation is consequently slow. This land, however, is not suitable for anything else and the clothing of every available spot with trees adds to the cover on the watershed and should in time assist in the preservation and probable increase of our much needed water supply. The number of trees planted on the watershed during the past two years was 4,416 in 1919 and 3,502 in 1920 or a total of 7,918 trees. These consisted of koa, mahogany and Australian red cedar.

SUB-NURSERIES.

It became necessary to enlarge and better equip our sub-nurseries on the other islands, after the passage of Rule XX of the Division of Plant Inspection, forbidding the shipping of trees from Oahu to any of the other islands with soil about their roots. The object of this rule is a precaution against the transportation of insect pests and diseases liable to be introduced from foreign countries. Honolulu being the principal port of entry for vessels trading with other countries makes Oahu more liable than any of the other islands to be first infested.

HILO SUB-NURSERY.

The writer made two trips to Hilo for the purpose of assisting in the starting of a new nursery large enough to supply the island of Hawaii with all kinds of trees and other plants desired. Consequently the nursery was moved from the Catholic Mission School to the Animal Quarantine Station, two miles out from the center of Hilo. This nursery has been in charge of Brother Matthias Newell for a number of years as shall also the new nursery at the Animal Quarantine Station. A good start has been made at the new nursery. A potting shed and small office has been built, water has been laid on the ground and tables and benches for holding seedlings, transplants and pot-grown plants have been installed. Supplies of different kinds of seeds suitable for the demand have been forwarded from time to time from Honolulu; also a quantity of plants packed and shipped in moss. The new nursery will be in good running order in a short time now and the whole island can be supplied from this nursery.

We appreciate very much the kind assistance rendered by Dr. H. B. Elliot, who has done everything in his power to help the work along. We are therefore indebted to him for such courtesies and help as he has rendered in making the establishment of this new nursery a success.

MAUI SUB-NURSERY.

The writer made two visits to Maui for the purpose of assisting in the starting of a nursery to supply Maui and Molokai with trees.

Mr. James Lindsay, Forest Ranger, was appointed to take charge of the nursery which is located at his residence at Haiku. Additional equipment had to be installed, a new potting shed and stands and benches built, water laid on and general tools for operating the work supplied.

This nursery is now in very good running order and has a large supply of many species on hand for distribution.

KAUAI SUB-NURSERY.

The nursery at Kalaheo, in charge of Joe Rita, Jr., has not been visited by the writer since the new law took effect, but a visit is contemplated in the near future. Seeds have been supplied at intervals and we expect to give him additional equipment so as to increase the output of this nursery.

ADVICE AND ASSISTANCE.

The writer has been called upon to make a large number of visits and give advice on tree planting and other subjects by people living in and around the city. All the different military posts on Oahu have been visited a number of times at the request of the officers for advice on the planting and improvement of their respective posts.

NURSERY GROUNDS.

The parking around the offices and the park part of the grounds has been kept in order by two men, with assistance occasionally from an additional man at odd times who is generally employed doing such work as attending to the fixing of pipes, doing rough carpenter work, etc., both at the Government Nursery on King Street and at the Makiki Nursery.

YEARBOOKS AND VEGETABLE SEED.

From our delegate in Congress we have received the usual consignments of U. S. Department of Agriculture yearbooks and vegetable seeds. These have been distributed throughout the Territory and have been much appreciated by recipients. A large supply of fresh seed is now on hand as well as back numbers of the yearbook which we will be glad to send out to applicants.

Respectfully submitted,

DAVID HAUGHS,
Forest Nurseryman.

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SOME BOTANICAL AND ENVIRONMENTAL ASPECTS OF HAWAII

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Few regions anywhere are more interesting botanically than the Hawaiian Islands.

Owing to their extreme isolation, separated by 2,000 miles of ocean from the nearest land mass of any size, there is an extremely high percentage of endemic species, many of them remarkably specialized, testifying to the long period during which evolution has been going on with little disturbance from outside.

Except for the almost uniformly volcanic nature of the soils, which has no doubt been a factor in the evolution of the flora, the conditions are extremely varied. Owing to the great height of some of the mountains, which in the two great cones on the island of Hawaii, Mauna Kea and Mauna Loa, rise to nearly 14,000 feet, and overtop all the mountains of Polynesia and Australasia, there is a corresponding range of temperatures, from the tropical heat of the lowlands, to regions of almost perpetual snow. The variation in precipitation is also extraordinary, ranging between an annual rainfall of 400–500 inches in extreme cases,[1] to less than 20 inches in some of the dry leeward districts. These remarkable differences of elevation, temperature and moisture occurring within a quite small area afford the botanist unusual facilities for investigating a wealth of extraordinarily interesting problems in plant evolution.

The writer has made several visits to Hawaii, the last in the summer of 1919. Two years before, a trip was made for the purpose of collecting Hepaticae for comparison with certain East Indian species which indicate an interesting similarity in the hepatic floras of the two regions. This led to a somewhat critical study of the Hawaiian flora as a whole, which revealed an unexpected and most remarkable affinity with that of the Australasian and Indo-Malayan regions. So many were the correspondences that they led inevitably to the conclusion that these could only be explained satisfactorily by assuming the existence of some ancient land connections which have disappeared in a great general subsidence of the whole Polynesian area.

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[1] A five years' record on Mt. Waileale, Kauai, showed an average annual precipitation of a little over 500 inches. See Science for November 23, 1917, pp. 511–512.

The results of these studies have been published already[2] and will not be enlarged upon here.

The Hawaiian Archipelago consists of a chain of islands extending from northwest to southeast, between lat. 18° 55′ and 21° 15′. Its total area is 6,454 sq. mi., of which nearly two thirds is comprised in the southernmost island, Hawaii. To the N.W. a long series of small islets or reefs extends for about 18 degrees. All the islands, except for the coral reefs are volcanic; but at present the volcanic activity is restricted to the island of Hawaii, which has two enormous active craters, where the process of mountain building can be seen at any time. Volcanic outbursts of spectacular proportions have been a feature of the past two years, and last September a large lava flow burst out of the flank of Mauna Loa, and finally reached the sea, where it built out a promontory of considerable size.

In the older islands all activity ceased long ago, and the disintegration of the volcanic soils is complete; but in Hawaii, and to a lesser degree elsewhere, there are large expanses of bare lava, nearly or quite destitute of vegetation. The volcanic activity has evidently developed along a rift beginning at the northern end of the present chain of islands, and has proceeded southward, where it is now seen in the active craters of Hawaii.

There is strong evidence that all the large islands were once united into a single much larger land-mass, which through subsidence has gradually segregated the islands as they now exist. The northernmost island, Kauai, was the first to be detached, this being indicated, both by the deep and broad channel between it and its neighbor to the south, Oahu, and by the very highly specialized nature of its flora. The proportion of endemic species is higher in Kauai than in any other island, although it is one of the smallest.

The topography of the islands, especially the older ones, is excessively rugged. The windward districts are drenched with torrential rains, deposited by the moisture-laden North East trades. The resulting erosion has made innumerable deep and precipitous canyons, whose walls are often almost perpendicular. These vertical cliffs, "palis," whose brinks are often concealed by dense vegetation, make it very dangerous to wander about without a reliable guide.

In the older islands the mountains are much worn down and the highest summits are only 4,000–5,000 feet in elevation. The great cones of Maui and Hawaii, the most recent of the islands, however, are much higher, Haleakala on Maui being about 10,000 feet high, and Mauna Loa and Mauna Kea on Hawaii, nearly 4,000 feet higher.

On these lofty islands nearly all the moisture is precipitated on the windward (N.E.) side, while in the less elevated islands, much of the moisture is carried over the summits of the mountains and precipitated on the leeward side. This is seen very clearly back of Honolulu, where the heaviest precipitation is at the head of the valleys on the leeward side of the mountains. The leeward shores are relatively dry, and even arid in many places, so that the contrast between the scant vegetation of the sun-baked lee shores and the rank vegetation of the upland bogs and rain forest is sufficiently striking.

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[2] "The Derivation of the Flora of Hawaii." Leland Stanford Junior University Publications, 1919.

Little is left of the indigenous vegetation of the lowlands, except in some of the most barren districts—and even in these, exotic species have to a great extent driven out the native. Thus in some of the waste rocky districts near Honolulu, prickly pear cactus has taken almost complete possession. Practically all of the arable land of the lower levels is under cultivation, the huge plantations of cane and pineapples monopolizing most of the land not occupied by rice-fields, taro patches and home gardens. Most of the conspicuous trees, shrubs and weeds are introduced, and give to the casual observer an entirely erroneous impression of the native flora. In the neighborhood of Honolulu, for instance, the two most conspicuous trees are the Algarosa (*Prosopis* sp.) and Iron wood (*Casuarina equisetifolia*). Both of these are of comparatively recent introduction, but have become completely naturalized and have all the aspect of being indigenous. It is highly probable, also, that the cocoanut palms were introduced by the natives when they invaded the islands. Many foreign weeds have become thoroughly established, and in the hills back of Honolulu almost impenetrable thickets of Guavas and Lantana have taken possession, while in the dryest places the prickly pear and thorny acacias thrive. In the moister parts of the islands some very attractive exotics have become naturalized. Wild ginger (*Hedychium coronarium*), *Canna indica, Clerodendron* sp., Ipomoeas, and passion flowers are common along the roadsides and in the woods about Hilo and in the rainy valleys back of Honolulu, and elsewhere.

The strand flora includes such widespread types as *Hibiscus tiliaceus, Ipomoea pes-caprae, Scaevola frutescens,* Pandanus, and Calophyllum,—all types familiar to anyone acquainted with the strand vegetation of the Eastern tropics and the South Seas; but the strand flora as a whole is very poor when compared with the latter regions. There is a considerable number of endemic strand plants, but these are, as a rule, not very common, and are often very much restricted in their range.

While little is left of the lowland native vegetation, except for the strand flora, the forests, where they have not been destroyed—intentionally or otherwise—harbor many very peculiar indigenous trees and shrubs, as well as a rich flora of ferns, liverworts, mosses, lichens and fungi. Herbaceous flowering plants are relatively scarce.

The predominant trees of the lower forest are two—the "Kukui" (*Aleurites Moluccana*), and the "Ohia" or mountain apple (*Eugenia Malaccensis*). The former is very conspicuous on account of its pale silvery green leaves, which contrast strongly with the dark green foliage of the other forest trees. Its oily seeds were formerly much used by the natives. The showy red fruits of the Ohia are very refreshing and are relished by the white inhabitants as well as the natives. As both the Kukui and Ohia are of considerable economic value, and as they are common in the South Pacific regions, it may well be that their seeds were brought to Hawaii by some of the early native immigrants.

The upper forest zone—3,000–4,000 feet, especially on the windward side of the islands, is a pronounced rain forest, with dense undergrowth and many epiphytes. These include numerous ferns, among them several species of filmy ferns, the big bird's nest fern (*Asplenium nidus*)—*Ophioglossum pendulum,* several species of Lycopodium and various other forms. The lianas are not abundant, the most conspicuous being a Freycinetia, which, however, is more abundant at lower elevations.

The predominant tree of all the higher forest is *Metrosideros polymorpha,* which is extremely adaptable, as it occurs at all altitudes from near sea-level to more than 4,000 feet in elevation. The showy red flowers are produced in great profusion and are assiduously visited by some of the honey-sucking birds belonging to the peculiar Hawaiian family Drepanididae.

An examination of the trees and shrubs of the lower forest zone will show that many of the genera are characteristic of the South Pacific regions, Australasia, and Indo-Malaya. Pandanus and Freycinetia represent the Pandanaceae, quite absent from America, and many others are members of extra-American genera. Among these are Pittosporum, Gardenia, Coprosma, Metrosideros, Santalum, Cyrtandra, Dracaena and others. This affinity of the flora with the regions to the south is shown also by the Pteridophytes and Hepaticae.

The preponderance of Old World and Australasian genera, and the paucity of American types, is the most remarkable feature of the vegetation as a whole.

As in all tropical mountain forests ferns constitute a conspicuous part of the vegetation. Tree ferns of the genus Cibotium abound in all the rain-forests, and are especially fine in the mountain forests of Hawaii. The peculiar Hawaiian genus Sadleria develops a short trunk, but is much inferior in size to Cibotium. The Marattiaceae are represented by a single species, *Marattia Douglasii.* There are several species of Ophioglossum, including the striking epiphytic *O. pendulum* and several species of Gleichenia are abundant. There is a single species of Schizaea, and several Hymenophyllaceae, in addition to a large number of Polypodiaceae.

There are no Gymnosperms, and several widespread tropical genera that one would expect to find are absent. Most noticeable perhaps is the absence of any native species of Ficus, one of the most widespread genera of trees. The Orchidaceae are very poorly represented, only three species being recorded from the Islands, and there are no Araceae that can with certainty be considered as truly indigenous.

There are a good many endemic genera, mostly trees and shrubs, belonging to several families. Among these are Platydesma (Rutaceae), Pterotropia and Cheirodendron (Araliaceae), Gouldia and Straussia (Rubiaceae), Raillardia, Hesperomannia (Cauposítae). Perhaps the most interesting family, from the standpoint of evolution, is the Lobeliaceae. This family has developed in a most remarkable way in Hawaii, and contains some of the most striking members of the flora. The genus Lobelia is represented by a number of species, but it is the two endemic genera, Clermontia and Cyanea which show the most remarkable developments. Some of these are tree-like, the largest 10 metres or more in height, the tall stems sometimes unbranched, and terminating in a palm-like crown of huge lanceolate leaves, below which are clusters of curious flowers.

The only indigenous palms belong to the genus Pritchardia. These are small or moderate-sized fan palms, occurring on all the islands, but not in great numbers.

OAHU

The Island of Oahu, upon which is situated Honolulu, naturally has been most exhaustively studied botanically. The immediate vicinity of the city is entirely under cultivation, and practically nothing is left of the original vegetation. Back of the city, however, are several valleys indenting the low mountain range extending the greater part of the length of the island. At the heads of these valleys and above them, there still remains a considerable extent of forest, which harbors many of the interesting indigenous plants and gives a fairly good idea of the character of the original flora.

The main range of Oahu is low, scarcely exceeding 3,000 feet at its highest point, and the moisture-laden trade winds pass over the summit and deposit a large share of their moisture at the head of the valleys on the leeward side. There is a remarkable difference in rainfall between the head of these valleys, where it may reach 200 inches annually and the dry coastal district at their openings, only a few miles distant, where it may be less than one fourth as much.

Of the valleys back of Honolulu, one of the largest is Manoa, whose physiography and vegetation have been discussed at some length in a recent paper by McCaughey.[3] The lower part of the valley is now part of the city, and even before this was the case, the floor of the valley had been taken up by the gardens and plantations of the natives, so that the native vegetation has long since disappeared. The head of the valley, however, still harbors much of the original forest, although the lower levels have been so ravaged by cattle and the inroads of wood cutters, etc., that most of the forest has disappeared and a jungle of guavas, Lantana, and other introduced shrubs and weeds have pretty effectually driven out the original growths. One of the worst weeds is the Hilo grass (*Paspalum conjugatum*), which rapidly invades the least clearing in the forest and soon chokes out the ferns and other delicate plants which form the natural ground cover. The rank growth of the grass makes it impossible for most tree seeds to germinate, and the doom of the forest is sealed.

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[3] McCaughey, V. American Journal of Botany, 4: 561–603, December, 1917.

Where the lower forest still exists, it is composed largely of the Kukui (Aleurites) and Ohia (*Eugenia Malaccensis*) already referred to.

Above the Kukui zone is a region characterized by another important native tree, *Acacia Koa,* allied to the phyllode-bearing Australian species. Above the Koa zone is the rain-forest in which are found many of the characteristic native trees and shrubs, very largely endemic species. Among these are species of Antidesma, Cheirodendron, Eugenia, Ilex, Hesperomannia, Metrosideros, Osmanthus, Pelea, Pittosporum, Pritchardia, Santalum, Suttonia, Straussia, Clermontia, Coprosma, Cyanea, Hibiscus, and others.[4] In this rain forest there is a rich growth, also of ferns, liverworts, and mosses.

The gardens of Honolulu are famous for their display of tropical and subtropical vegetation. One may see there most of the gorgeous flowering trees, shrubs and climbers of the tropics as well as many varieties of tropical fruits. A specialty of the Honolulu gardens is the great variety of Hibiscus. The scarlet *H. rosa-sinensis* has been crossed with some of the handsome native species and the result is a wonderful variety of most beautiful forms. The garden planted by the late Dr. Hillebrand, author of the Flora of Hawaii, still exists and contains magnificent examples of many rare palms and other tropical trees, some of really gigantic size.[5]

KAUAI

The northernmost island, Kauai, is the richest of the islands in number of species, and in the percentage of endemics. It is also the most productive in proportion to its size, the fertile soil and abundant water giving it the popular name of the Garden Island. The greater part of the area is occupied by an elevated plateau about 4,000 feet high, rising in the center of the island to 5,000 feet in Mt. Waileale. The latter is, so far as records show, the rainiest spot in Hawaii, and certainly one of the wettest anywhere (see footnote 1). The region about Waileale is occupied by grassy bogs and swampy forests of scrubby trees, which are extremely difficult to traverse as the writer can testify. The open bogs are much like those of northern regions and harbor many temperate plants, such as *Drosera longifolia*, Sphagnum, species of Rubus, Vaccinium, Viola, Geranium, and various coarse grasses and sedges. This region is also characterized by a number of single representatives of genera which according to Hillebrand belong in the Antarctic regions, New Zealand, Falkland Islands, and the Southern Andes.[6]

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[4] For details see McCaughy, loc. cit.

[5] For a detailed account of the ornamental trees, the reader may refer to Prof. J. F. Rock's "Ornamental Trees of Hawaii (Honolulu, 1917).

One of the most conspicuous plants of the wettest rain forest, found in all the large islands at elevations of 3,000 to 4,000 feet, is *Gunnera petaloidea* Gaud., which suggests a particularly luxuriant rhubarb, the huge leaves being 3 to 4 feet across, or even more. The genus is best developed in New Zealand, but has representatives in Chile and one species in the Malay Archipelago, but is not known elsewhere in Polynesia.

MAUI

Maui, the second in size of the islands, consists of two parts, East and West Maui, connected by a low isthmus. These two parts are of different ages. West Maui is evidently much older, and it is thought may have been connected, formerly, with the Kohala Mountains in N. E. Hawaii. The summit is almost 6,000 feet in height, and is occupied by bogs, said to be much like those in Kauai; and there are deep gorges on the windward side cut out by streams of considerable size.

East Maui is made up entirely of the gigantic volcanic mass of Haleakala, 10,000 feet high, with a huge extinct crater over twenty miles in circumference, and 2,000 to 3,000 feet in depth. Although there is no record of eruptions, there is every evidence that activity has ceased only in relatively recent times, and the lava flows within the crater look as if they had just been formed.

Much of the forest on the dryer slopes of Haleakala has been entirely destroyed by cattle, but in the wetter districts there are still dense rainforests of the most pronounced type. These are best developed at about 4,000 feet elevation. Above this the precipitation is much less and the whole summit of Haleakala is decidedly arid.

HAWAII

From an ecological standpoint, Hawaii, much the largest of the islands, is perhaps most interesting, although it is much poorer in number of species than the older islands. A small district in the northeast corner is occupied by the low range of the Kohala Mountains, very much older than the rest of the island, and probably once connected with West Maui. The greater part of Hawaii is composed of three large volcanoes, Mauna Loa, Mauna Kea, and Hualalai. The former is still in activity, and has two enormous craters, one of which, Kilauea, is familiar to all the tourists who visit Hawaii. The summit crater is difficult of access and is seldom visited. Owing to the presence of this great active volcano, such problems as the effects of volcanic eruptions upon vegetation, the invasion of recent lava flows by plants, and the establishment of new plant societies, and kindred problems, can be carried on in Hawaii as they can scarcely anywhere else. Owing to the great elevation of the mountains nearly all the moisture is precipitated on the windward side of the island, and much of the leeward or "kona" side is a desert of dead lava. Hilo, the principal town, is situated on the windward side, and the whole district is extremely wet, the annual rainfall in Hilo being not far from 200 inches. Being the most southerly of the islands, this great rainfall results in an extremely luxuriant vegetation and Hilo is decidedly the most tropical-looking place in all the territory.

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[6] F. Hillebrand: "Flora of the Hawaiian Islands," Introduction, p. xxiv.

Formerly covered with forest to the water's edge, the lower slopes of the mountains are now completely cleared, and up to 2,000 feet they are principally devoted to cane fields. Above this, owing largely to the ravages of cattle, the forests are rapidly disappearing.

The rain-forest is evidentry very quickly affected by any disturbance of the balance of species, and the invasion of cattle or other herbivorous animale not only destroys the native undergrowth, but allows the intrusion of weeds, especially the Hilo grass, which quickly destroys the ground cover of ferns and other delicate plants, and makes it impossible for the forest to perpetuate itself, both because the trees cannot long survive this exposure resulting from the destruction of the undergrowth, and because the conditions for germination of their seeds have been destroyed. Very soon the trees die, and what was a dense jungle becomes an open waste of grass and weeds, with the shabby remnants of a few tree ferns, and the stumps and skeletons of dead trees (an example of forest destruction along the road from Hilo to the volcano is described below).

The destruction wrought by grazing is seen on a large scale on the slopes of Haleakala in Maui, and on the Waimea plains of Hawaii. In some parts of the Islands, goats have run wild, and are the source of much damage to the vegetation.

The effects of erosion on the windward side of Hawaii are very remarkable. From the steamer approaching the shore there are visible the openings of deep valleys, cutting through the high cliffs which fall perpendicularly into the sea. Not infrequently the stream which has cut the gorge forms a cataract over a high cliff into the ocean.

Through the kindness of Dr. H. A. Lyon of Honolulu, the writer had an opportunity of collecting at the head of the largest of these gorges, Waipio Valley, which extends into the Kohala Mountains, the oldest formation of the Island.

The head of Waipio gorge divides into several branches, whose almost sheer walls fall straight to the floor of the canyon, 3,000 feet below. The cataracts falling over these vertical cliffs, except for their lesser volume, recall some of the falls of the Yosemite Valley. A narrow trail skirted the brink of this tremendous chasm, and above it rose a rocky wall, indented here and there with little caves, and covered thickly with a wonderful profusion of ferns, liverworts, and mosses, the liverworts in particular being extraordinarily abundant and luxuriant. Everything pointed to a tremendous rainfall, and we had a practical illustration in a succession of heavy showers which drenched us to the skin. At one place great cushions of Sphagnum were seen, an unusual sight in Hawaii, and beyond the gorge was an extensive nearly level boggy region, full of interesting plants, including a few specimens of a fan palm (*Pritchardia lanigera*). In this remote region very few introduced plants had got a foothold, the vegetation being almost entirely composed of truly indigenous species, among which were a number of interesting Lobeliaceae.

Very different was the aspect of the great Waimea plain, only a few miles from the Waipio gorge, and extending to the lower slopes of Mauna Kea. This region was formerly heavily forested but is now a treeless plain, the grazing ground for thousands of cattle.

The region about Hilo is very interesting botanically, although one has to go a long way to find the forest still standing. Owing to the great humidity, rain-forest types may be found near sea level, in gorges where remnants of the forest still remain. Filmy ferns, many liverworts, and species of trees and shrubs which usually grow at much higher elevations may be found. A remarkable instance was seen near Hilo. In 1881 a great lava flow almost reached the city, which was threatened with destruction. The great expanse of lava is still easily recognizable, although it is covered with the beginnings of a new forest. The roof of a large lava tunnel has broken through, forming a cave, open above, but well sheltered from the sun and wind. In this cave there is a luxuriant growth of ferns and liverworts, as well as some thrifty trees and shrubs, which have grown much better than their companions on the exposed lava above them.

Dr. Lyon pointed out a most interesting fact, viz., that practically all the plant colonists on the lava were strictly indigenous species. The introduced plants, like the weeds abounding along the roadside and in the cultivated land in the immediate vicinity, failed to obtain a foothold on the lava, while the indigenes seemed to find exactly the conditions they needed.

The most important element of the embryo forest is *Metrosideros polymorpha*, which quickly appears in Hawaii upon the recent lava flows. In the rain-forest, this tree most commonly begins as an epiphyte, especially upon tree-ferns, and often develops stilt-roots like those of many species of Ficus. As seems to be always the case in the colonizing of fresh volcanic soils, Pteridophytes play an important rôle. The characteristic fern, *Sadleria cyatheoides*, and species of Lycopodium and Psilotum, are among the early growths to appear; and a Vaccininum, with showy red and yellow berries, the "Ohelo" of the natives, is a common and conspicuous denizen of the lava.

A visit to the volcano was not without its melancholy aspects. When the writer made his first visit to this remarkable place in 1892 the greater part of the road from Hilo was through a dense unspoiled rain-forest. In some of the lower forest the undergrowth had been partly removed for the planting of coffee but otherwise the forest was left intact, and there was most interesting collecting within a short distance of Hilo. Now all the lower forest has disappeared to make way for cane, which covers all the available land. Most of the forest along the volcano road has either been cut down or has been so ravaged by cattle and the consequent encroachment of Hilo grass and other weeds, that very little of it is left. The last forlorn stragglers of the myriads of tree ferns that formerly lined the road, are slowly dying, exposed to the sun and wind, and the skeletons of dead trees rise from a waste of tangled weeds and grass.[7]

The country about the crater of Kilauea is decidedly interesting botanically. It is much dryer than Hilo and further on becomes very barren. Much of the region about the crater is covered with recent lava flows upon which a sparse vegetation has developed which gives a fair index as to the age of the different flows. Occasionally quite heavily wooded patches are seen, showing areas that were surrounded by the lava-flows but escaped destruction. These islands of older vegetation, "Kapukas" in the native tongue, are very interesting features of the region about the volcano.[8]

The remains of a magnificent forest of Koa (*Acacia Koa*) still exist not far from the volcano, but this has been used as pasture and invaded by Hilo grass, so that apparently seedlings cannot get a start, as nothing but mature trees can be found. Twenty-five years ago there was a fine undergrowth of tree-ferns and other native plants, but these have pretty much vanished and it will not be long before the forest has disappeared unless steps are taken to restore something like the original conditions.

Of the rain-forest below the crater, little is left in the vicinity of the volcano. A few small tracts have been enclosed—notably one belonging to Mr. W. M. Giffard of Honolulu, who kindly permitted the writer to collect there. These enclosed tracts show what the forest was in earlier days. Especially striking are the beautiful tree-ferns—*Cibotium Menziesii* and *C. Chamissoi*—which formerly abounded throughout the forest regions between Hilo and the volcano. A profusion of small ferns, as well as dense growths of liverworts and mosses cover the trunks and lower branches and even the leaves of the trees and shrubs.

An unusual and interesting little collection of plants was met with close to the active crater. Steam vents opening into a rift near the wall of the crater produced a small natural hot-house, where the heat and moisture had caused quite a luxuriant growth. The wall of the fissure, close to the steam vents, was covered with a thick, slimy coating of several species of Cyanophyceae, which displayed various bright tints. On the ground were several ferns and other plants, including an Ophioglossum, which has not been found elsewhere at this elevation, but occurs at sea level in the warm lowlands.

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[7] [This is a particularly good example of the influence of the "biological factor" of the environment. We have enough—and too many—cases of forest destruction in this country, but few in which the identical spot has been described both before and after the destruction occurred.—Ed.]

[8] For a fuller account of the flora of the volcano region see Rock, "The Indigenous trees of Hawaii." Pp. 27–33. Honolulu, 1913.

Comparatively few of the native plants produce showy flowers, although there are some of marked beauty, such as several species of Hibiscus with large white or yellow flowers. Some species of Lobelia and Scaevola are quite showy, and the scarlet flowers of Metrosideros and the leguminous climber, *Strongylodon lucidum,* beloved of the honey-sucking birds, are very conspicuous. Near the volcano these birds are quite common, and when perched near the scarlet flower clusters of the Metrosideros it is not easy to distinguish the red bird from the red flowers. Most of these birds have a long curved bill, which seems specially adapted to probing the curved tube of the Lobelias and the long curved keel of the Strongylodon.

The great preponderance of Southern Pacific and Asiatic types in the Hawaiian flora is very evident. The writer has treated this topic at some fifty extra-American genera are common to Hawaii and the regions of the South Pacific and Indo-Malaysia, while the number of strictly American genera occurring in Hawaii is only six. There are nearly forty extra-American species of Pteridophytes common to Hawaii and the Australasian-Indo-Malaysian area, while only two peculiarly American species are known from Hawaii. The Hepaticae show much the same relations.

The animal life of the Archipelago shows much the same correspondence with the faunas of the Southern hemisphere as is shown by the floras of the two regions.

Various explanations have been offered as to the origin of the Hawaiian plants, based on the assumption that the Archipelago has always been completely isolated, and is of purely volcanic origin, having been thrown up from great ocean depths. The nature of the flora of the Islands is scarcely to be reconciled with such a theory, since a large proportion of the plants, whose nearest reatives are in Australasia and the Malay Archipelago, possess no provision by which they could have survived the long journey over four or five thousand miles of ocean. A large number of these plants, including such delicate forms as the filmy ferns and many liverworts, inhabit the cool rain-forests, and one finds it difficult to conceive any means of transport length in two earlier papers,[9] and will not dwell upon it at length here. Over from distant New Zealand or the mountains of Java and New Guinea to the mountain forests of Hawaii which would enable the spores of these delicate plants to survive the exposure of such a journey.

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[9] Campbell, D. H.: "The Origin of the Hawaiian Flora." Memoirs of the Torrey Botanical Club, 17, 90–96–1918.

Loc. cit., 1919.

It is evident that most of the forms have been in the Islands for a very long time, as a great majority are endemic, although related to species or genera in other parts of the world. The extraordinary degree of endemism is scarcely equalled anywhere else, and points to a long period of isolation since the introduction of the ancestors of the present flora. This long isolation has resulted in a good many endemic genera, as well as species.

The small number of American types is remarkable, inasmuch as there are agencies which might be expected to bring to the Islands a good many plant immigrants. A considerable number of birds are regular migrants from the West Coast of America, and the prevailing trade winds are from the same direction. Moreover ocean currents frequently bring drift from the Northwest American shores. None of these agencies can be called in to account for the transfer of seeds from the remote regions to the South, whence it is certain most of the plant life of the Islands has been derived.

It seems necessary, therefore, to assume some ancient, more or less direct, land communication with the regions of the Southern Pacific. There is good evidence of extensive subsidence in the Hawaiian Archipelago which has resulted in the formation of the separate islands that now exist. This is most strikingly borne out by the flora of Kauai, which it is believed was first cut off. The flora of Kauai is not only the richest in number of species, but the species are most highly specialized and many are found exclusively in this island, indicating an early separation of the island from the other members of the Archipelago.

The island of Hawaii offers a great contrast to Kauai. Many times larger, it is for the most part made up of recent volcanic formations, a considerable part of which are still almost destitute of vegetation. The flora of this great Island, except in the small area occupied by the ancient Kohala range, is much less varied than that of the older islands, and comprises relatively few species, which are not found in the other islands.

A similar subsidence probably has occurred throughout Polynesia, and it is likely that at some remote period, perhaps in the early Tertiary, there existed one or more large land masses over what is now Polynesia, the existing islands being the summits of sunken mountain masses.[10]

It is known that the Malayan Archipelago was once united with the Asiatic mainland, and that the southern extremity of the American continent was connected in some fashion with New Zealand. The remarkable similarity between the floras of Hawaii and these southern land masses indicates, in the opinion of the writer, that the existing flora of Hawaii is in large part descended from types which were widespread over the great land areas which in Tertiary time, perhaps, connected Hawaii with the ancient continents of the South Pacific. These ancestral forms, in the course of ages have become much altered in many cases, but others have persisted with but little change. Presumably a good many forms have become extinct, and a considerable number of new ones have been introduced from outside. This is probably true of all the species which are allied to types from the Pacific Coast of North America. The time when the isolation of the Archipelago became complete must be largely conjectural, but to judge from the character of the fauna, it may well have been in the Mid-Tertiary or possibly somewhat earlier.

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[10] [An interesting piece of work on this subject is H. P. Crampton's "The Zoological Facts of Distribution in Relation to the Problem of Subsidence in Polynesia," not yet published, and his "Studies on Variation, Distribution and Evolution of the Genus Partula; the Species Inhabiting Tahiti," Carnegie Inst. of Washington, Publ. 228, 1917.—ED.]

We may then conclude that the bulk of the vegetation in Hawaii is made up of residual types, *i.e.*, remnants of a flora common to the ancient much larger Hawaii, and the continental masses to the South. These ancient types have become more or less changed since the isolation of the Archipelago, and their number has been augmented by a relatively small number of forms introduced from America subsequent to the isolation of the Islands.

SUMMARY

The Hawaiian islands present extremely varied environmental conditions: mountains nearly 14,000 feet high give temperatures ranging from tropical heat to almost perpetual snow; the yearly precipitation ranges from less than 20 to over 500 inches; the soil varies from fresh lava to old well-disintegrated lava and alluvial valleys; the topography is rugged.

Practically all of the arable land of the lower elevations is cultivated.

Elimination of the undergrowth by man or grazing animals destroys the forest through exposing the trees and permitting the intrusion of Hilo grass.

The islands contain large numbers of endemic plants.

Only 6 strictly American genera occur in the Hawaiian Islands as compared with over 50 extra-American genera common to the islands and to regions of the Southern Pacific and Indo-Malaysia.

The large number of delicate forms whose seeds and spores could not survive transportation four or five thousand miles indicate a former land connection with the Southern Pacific islands. The ancient types forming the bulk of the vegetation have become more or less changed since the isolation of the Hawaiian Archipelago.

CHARTING QUADRATS WITH A PANTOGRAPH

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The quadrat method of recording changes in the composition of vegetation has been used by the Forest Service in connection with its various grazing investigations for a number of years. The accurate history thus compiled of the changes in plant formations, especially under different conditions of grazing, is invaluable in developing principles of range management. On the Santa Rita Range Reserve, in southern Arizona, eighty chart quadrats are mapped each year and as many more will be established in the near future. It is obvious to those familiar with quadrat charting that the mapping of this number of quadrats involves a great deal of work.

The method of charting heretofore followed is the common one in which straps are used to divide the quadrat into square decimeters, and the vegeta-

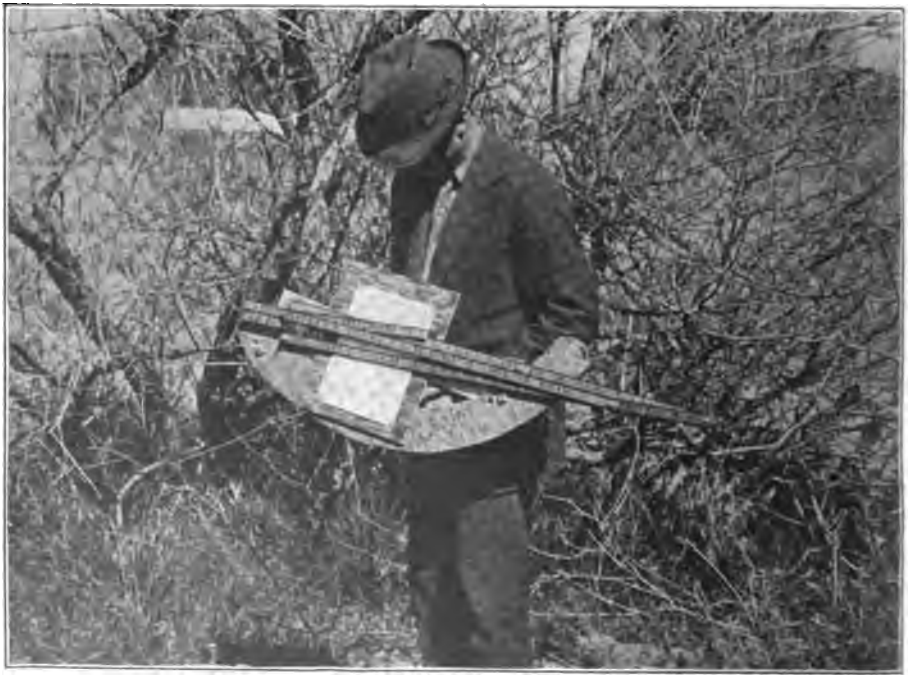

FIG. 1. Pantograph used for charting quadrats, folded for carrying.

tion within each decimeter is mapped on a reduced scale by ocular estimate, supplemented by actual measurement. The recognized disadvantages of this method led t[illegible]riter to experiment with the pantograph as a practical means of avoiding them. Now, the pantograph is commonly considered as adapted for use only when operated upon a drafting table. For mapping vegetation in the field it would seem quite unusable. Nevertheless the experiments showed surprisingly good results. In fact, when mounted upon a suitable frame the pantograph registers the outline of vegetation a[illegible] accurately as though the work were done on a drafting table. This is not to say that the result of this method of charting is a perfect reproduction of the outlines of vegetation; it is simply an accurate tracing of the outlines which were followed by the operator. The production of accurate charts is largely a matter of acquiring system and skill in guiding a needle around the outlines of plants.

As a result of the experiments with the pantograph the instrument was used in charting most of the established quadrats at the Santa Rita Range Reserve in the fall of 1919. The instrument (fig. 1) used is of wood with arms 40 inches long and set to reduce to 1/3.75 which, when applied to a meter quadrat produces a square approximately 10.5 inches on a side. A table 21 inches square, made of three-ply veneer and with demountable legs 10 inches high, was used to support the pantograph, which was mounted on a pivot at one corner. A metal leg 1 inch high with a ball roller, and attached to one arm, supported the instrument and, when the instrument was being used, swung back and forth across the table. The only other modification of the instrument was the substitution of a steel needle 10 inches long for the short needle used in tracing the outline of the figure to be reproduced. The needle not only supported one arm of the pantograph when not in motion but also enabled the outlines of the vegetation to be traced while the instrument remained high enough to be out of contact with the stems of the plants. The form for registering the charts was placed on the table after the instrument was set in position along one edge of the quadrat, and adjusted so as to record properly and then fastened with thumb-tacks.

It requires the services of two persons to chart successfully; one, who should be skilled in charting and familiar with the flora, to trace the outline of the vegetation and call out the proper symbols; the other to record the symbol for each species and to lift the recording pencil from one outline to the next. The equipment can be carried handily by the operators either on foot or on horse. An average day's work as conducted at the Reserve was the charting and describing of fifteen quadrats, although as many as twenty were completed in one day. An average day's work for one man using the hand method is four or five quadrats.

The advantages of charting meter quadrats with the pantograph as compared with the use of straps are:

1. The results are fully as accurate; the pantograph will record as accurately as the skill of the operator in following the outline of plants will permit.

2. The pantograph can be used with entire disregard of the presence of rocks or impenetrable soil—factors very important in using straps.

3. The rank growth of vegetation is even less of an obstacle to accuracy with the pantograph than it is with the strap method, because the foliage can readily be held with one hand while the outline of the plant is traced with the other. Where straps are used the rank foliage is very apt to prevent the straps from lying accurately in position.

4. The work can be done more rapidly with the pantograph and with much less tedium. (Two persons, only *one* of whom need be skilled, can chart fully three times as many quadrats with the pantograph as one skilled person can chart with straps.)

5. The pantograph is especially efficient in locating individual seedlings or one-stemmed plants and in tracing the outline of crowns of low bushes.

The principal disadvantage so far encountered in the use of the pantograph is the fact that the instrument is more cumbersome than the equipment used with the strap method. This is believed to be offset by the shorter time required to set up the pantograph. Moreover, the perfected instrument should be very easily carried and manipulated. The pantograph can be used on any degree of slope where quadrats are apt to be located; is equally useful whether the vegetation is scattered or dense; or whether it consists of perennials or annuals, and the data can be as readily compiled as the data obtained with the hand method, for in either case standard forms should be used in charting.

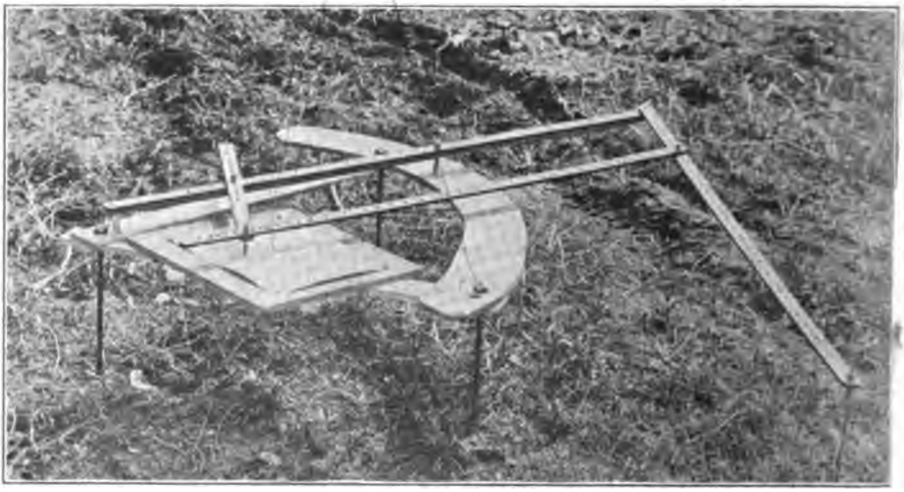

FIG. 2. Pantograph used for charting quadrats, set up ready for use.

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